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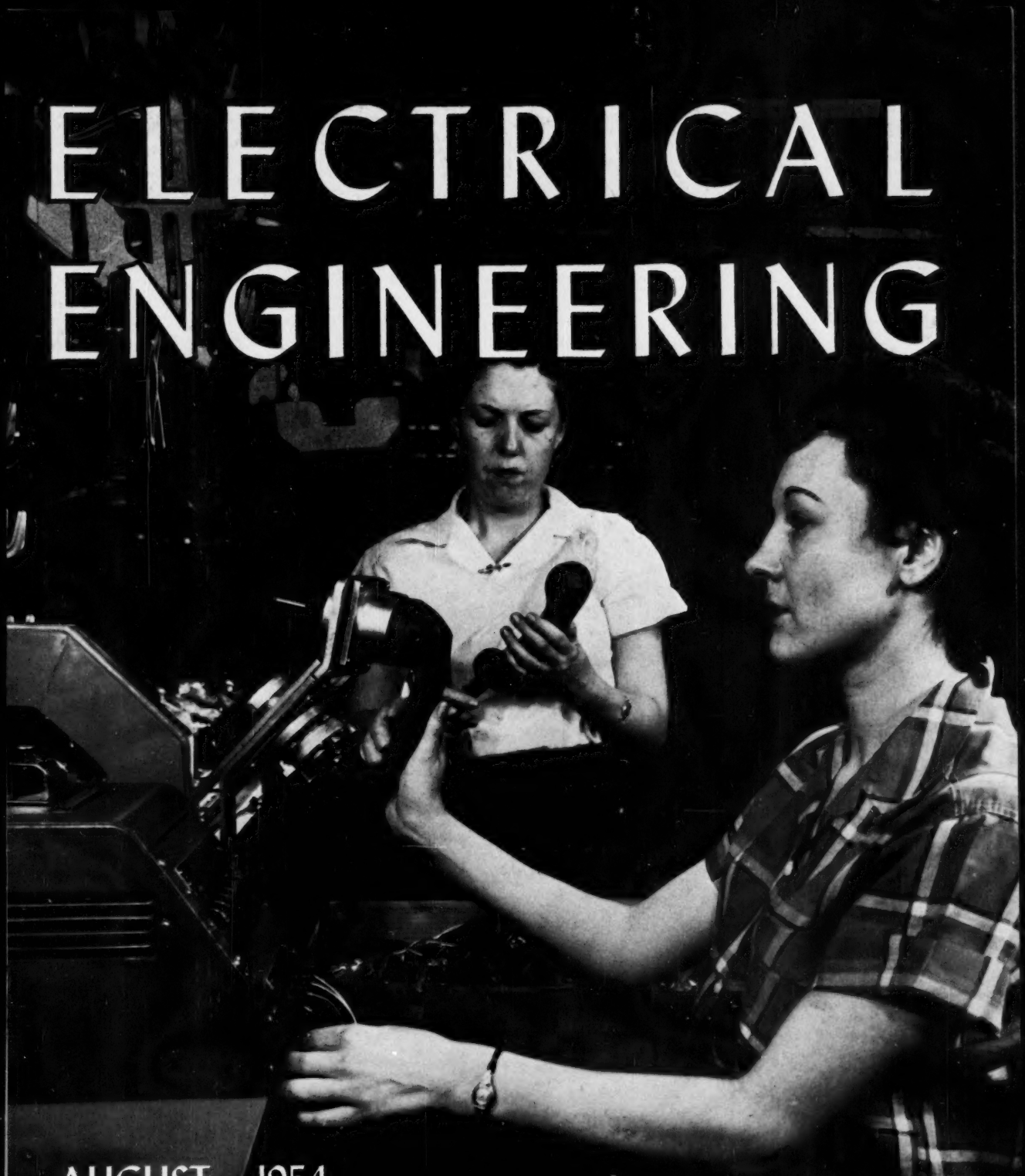

AUGUST 1954

PUBLISHED MONTHLY BY THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

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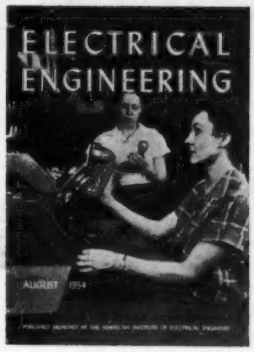

The Cover: Telephone sets in eight different colors are now being manufactured at the Indianapolis, Ind., Works of the Western Electric Company. Shown on the cover, the transmitter and receiver undergo test before reaching final assembly. For complete details see "Of Current Interest," pages 783–4.

AUGUST
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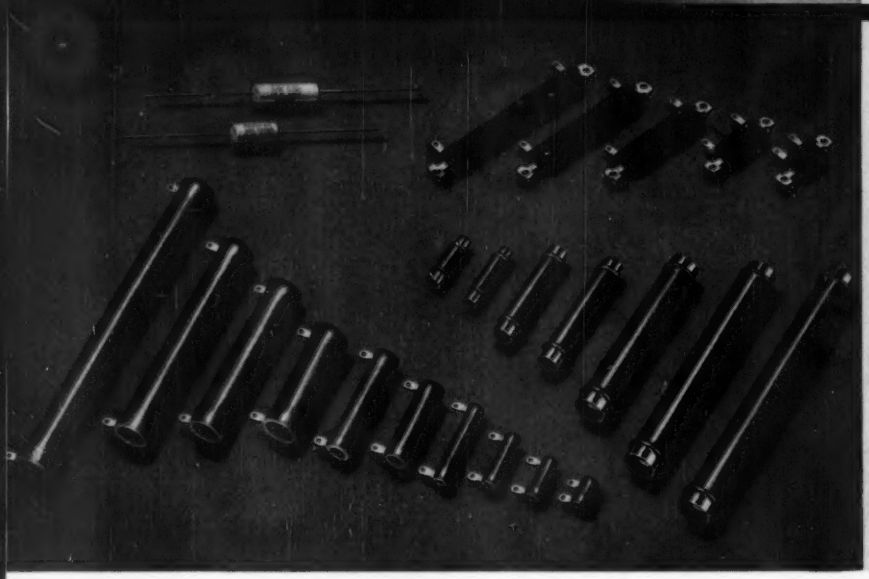

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HIGHLIGHTS.....

Board of Directors' Report. The 70th annual report of the AIEE Board of Directors covering the fiscal year ending April 30, 1954, is included in full in this issue. It contains brief summaries of the activities of the Institute and its committees during the year, and also includes the accountants' statements showing the financial condition of the Institute at the close of the fiscal year (*pp. 755–82*).

The Year's Achievements. In his final address as Institute President, Mr. Robertson examines some of the accomplishments and problems that have highlighted his term of administration. He also considers the broader question of the unity of the profession, which he feels must be resolved first on the level of the individual (*pp. 692–4*).

Henline Testimonial. During the Summer and Pacific General Meeting a portfolio of testimonial letters from past AIEE presidents was presented to Mr. Henline who recently retired as secretary of the Institute. Some brief excerpts from these letters have been compiled (*pp. 690–1*).

An Experiment in Unity. In June 1920 the American Engineering Council was organized by the engineering profession of this country in an attempt to achieve professional unity. Although the Council ceased functioning in 1940, the interest in unity is as great as ever and so this discussion of the Council's structure and problems is presented (*pp. 701–04*).

Lamme Medal. The Lamme Medal for 1953 was presented during ceremonies at the Summer and Pacific General Meeting to Frank A. Cowan of the American Telephone and Telegraph Company for his contributions to long-distance communication and the development of modulating and transmission measuring apparatus. The history of the medal, a description of the medalist's career, and Mr. Cowan's acceptance address are included in this issue (*pp. 714–18*).

Steinmetz Memorial Lecture. The Steinmetz Memorial Lecture, sponsored annually by the AIEE Schenectady Section, was delivered this year by Dr. Charles A. Thomas of the Monsanto Chemical Company. In this, the 26th lecture, Dr. Thomas discussed "Science, Progress, and the Human Mind" (*pp. 696–700*).

Golden Jubilee of the IEC. The annual meeting of the International Electrotechnical Commission (IEC) in Philadelphia, Pa., September 1–16, 1954, marks the organization's 50th anniversary. Since this is the first meeting of the IEC in the United States since 1926, many AIEE members will have their first opportunity to attend some of the sessions and discussions. A history of the IEC and the program for the meeting are presented (*pp. 720–2*).

Ten Founding Fathers of the Electrical Science—V. Ampere's electrical investigations were developed into an hypothesis that magnetism was essentially a phenomenon of electrified particles of matter. In his experiments demonstrating the principles of electrodynamics, he distinguished electromotive action as being of two kinds, those of electric tension and those of electric current. His experiments and observations in these fields are discussed (*pp. 724–5*).

Mechanical Properties of Aluminum Electric Bar. Data of special interest to designers and manufacturers wishing to use this bar are presented in terms of the compositions and forms available, typical properties, materials tested, and the test methods and results, properties of rectangular bars and tubular conductors, strength and resistance of welds, effects of temperature on tensile properties, and creep resistance (*pp. 706–11*).

Practical Use of Tracer Controls. Single-, 2-, and 3-dimension tracer controls have been incorporated in many types of machine tools and they are functioning satisfactorily; however, each time a tracer is put to some new use, problems arise to be solved. The effects of machine tool deficiencies and their corrections are set forth (*pp. 729–34*).

Harmonic Cancellation From Computing Voltage Source in Servo Analogue Computers. Emphasis is placed on the fact that the quadrature rejector circuit can be utilized to cancel the harmonics originating at the source of the computing voltage. It also shows that the system used for harmonic cancellation is dependent on the frequency response of the computing network. However, the type of frequency response obtained by the computing network determines the type of quadrature rejection circuit to be used (*pp. 711–13*).

Magnetic Ferrites: New Materials for Modern Applications. The outstanding properties and those applications of the available ferrites which have become available for commercial use are surveyed as they affect the design and manufacture of transformers and inductors for carrier telephone, radio, and television (*pp. 726–9*).

High-Frequency Alternators. The technological advances which have led to the realization of reliable lightweight alternators are summarized. The characteristic of a typical alternator used in high-performance systems is shown. This alternator is capable of delivering a power-to-weight ratio of 1 kw per pound and has a maximum power rating of 3 kw (*pp. 735–7*).

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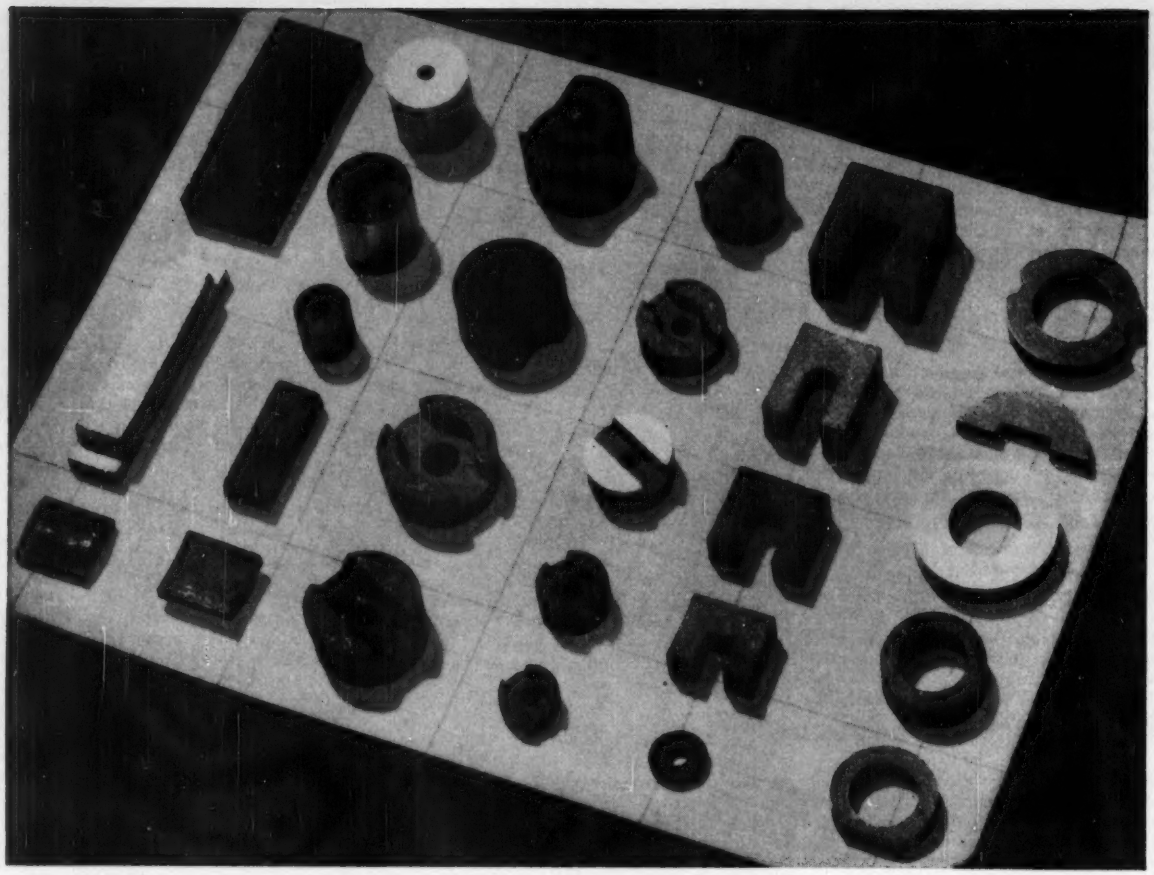

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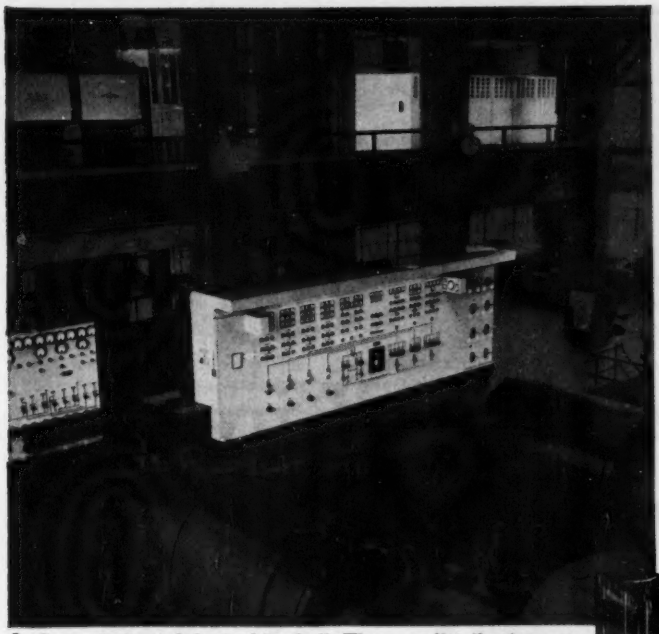
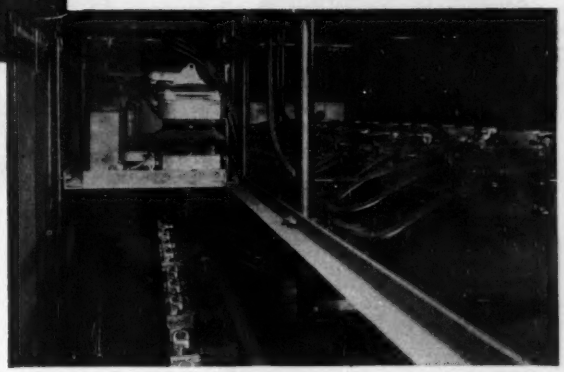


1. General view of the turbine hall. The new distribution control board is in the center, the old control board is at the left, and the old switchgear is above it on the balcony.

HAGERSTOWN SPECIFICATION:

no service interruption during installation . . . or after



2. Cable connections at main and auxiliary station service breakers. Surge protective equipment for station service bus is at left.

CABLE SPECIFICATION: *Okolite-Okoprene*

Specifications for the expansion and modernization of the Municipal Electric Light Plant of the City of Hagerstown, Maryland, were made unusually complex by the absence of auxiliary power sources. Interruption of service was impracticable and therefore considerable engineering study and planning by Albert C. Wood Associates, consulting engineers, were required to solve the design and construction problems involved.

Installation of the new 5,000-KW, 13.2-KV steam turbine generator, it was determined, would overstress the old open framework and concrete cell switchgear. Therefore, new 2.4-KV and 13.2-KV metalclad switchgear was installed, and arrangements were made to tie-in the new switchgear by paralleling circuits. The new equipment was energized a circuit at a time.

All material specified for the installation was selected only after extensive evaluation of reliability and suitability. *Okolite-Okoprene was chosen for all cable requirements of the project.* Okolite-Okoprene was used on all switchgear, control board, generator and exciter equipment as well as bus tie transformers and sub-stations.

Recognized throughout the power industry for outstanding dependability and long service life, Okolite-Okoprene exceeds industry standards for quality and durability. Write for Bulletin EG 1075 for complete information on the outstanding advantages of Okolite-Okoprene rubber-insulated cables for high voltage use. The Okonite Company, Passaic, New Jersey.

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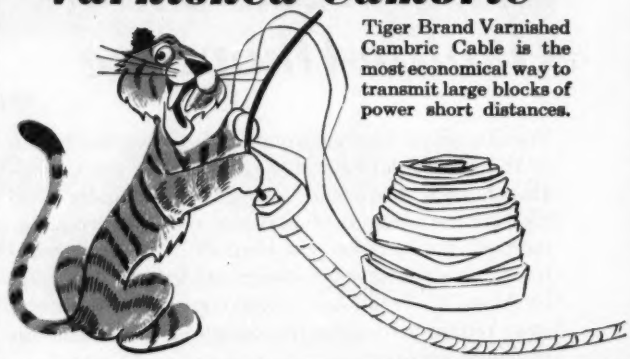

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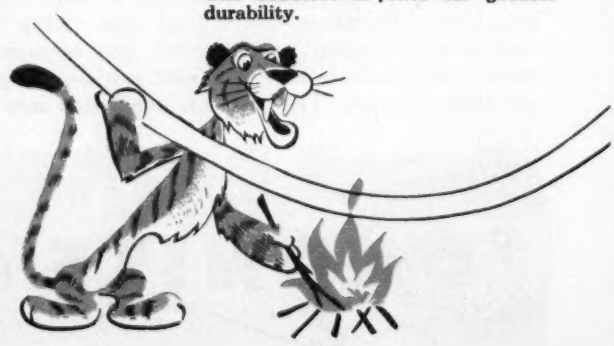

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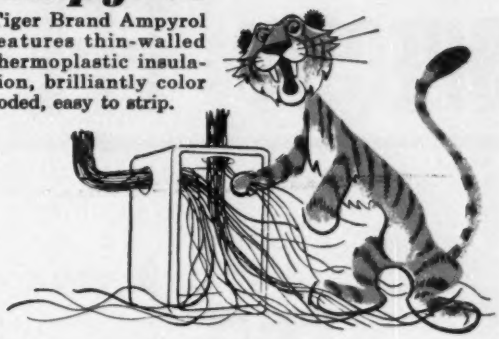

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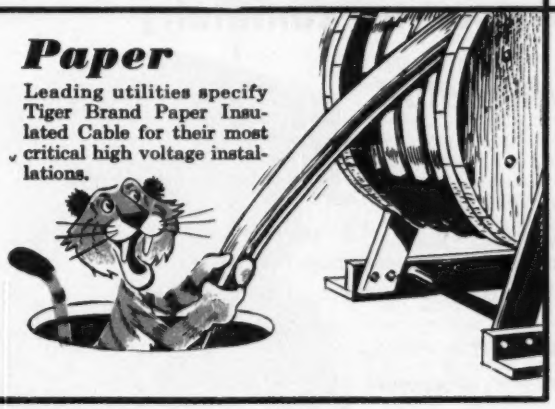

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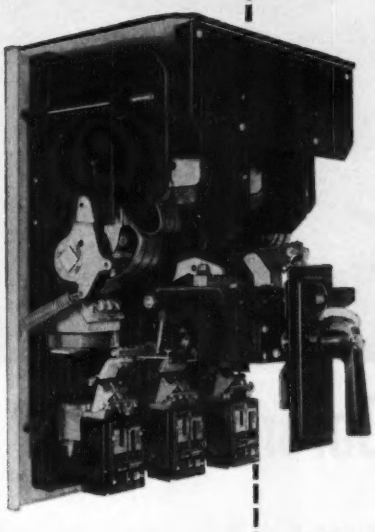

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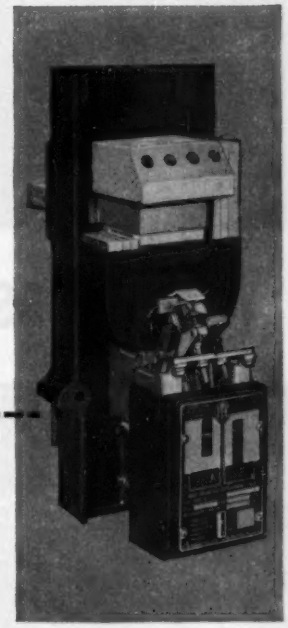

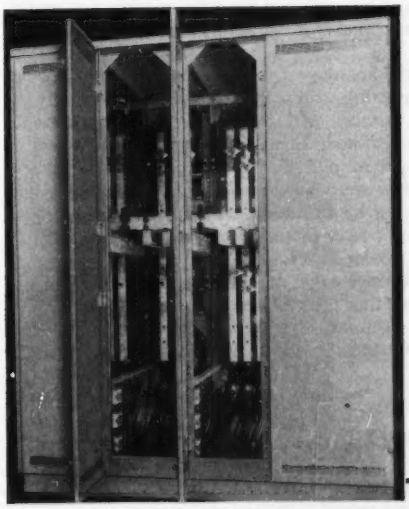

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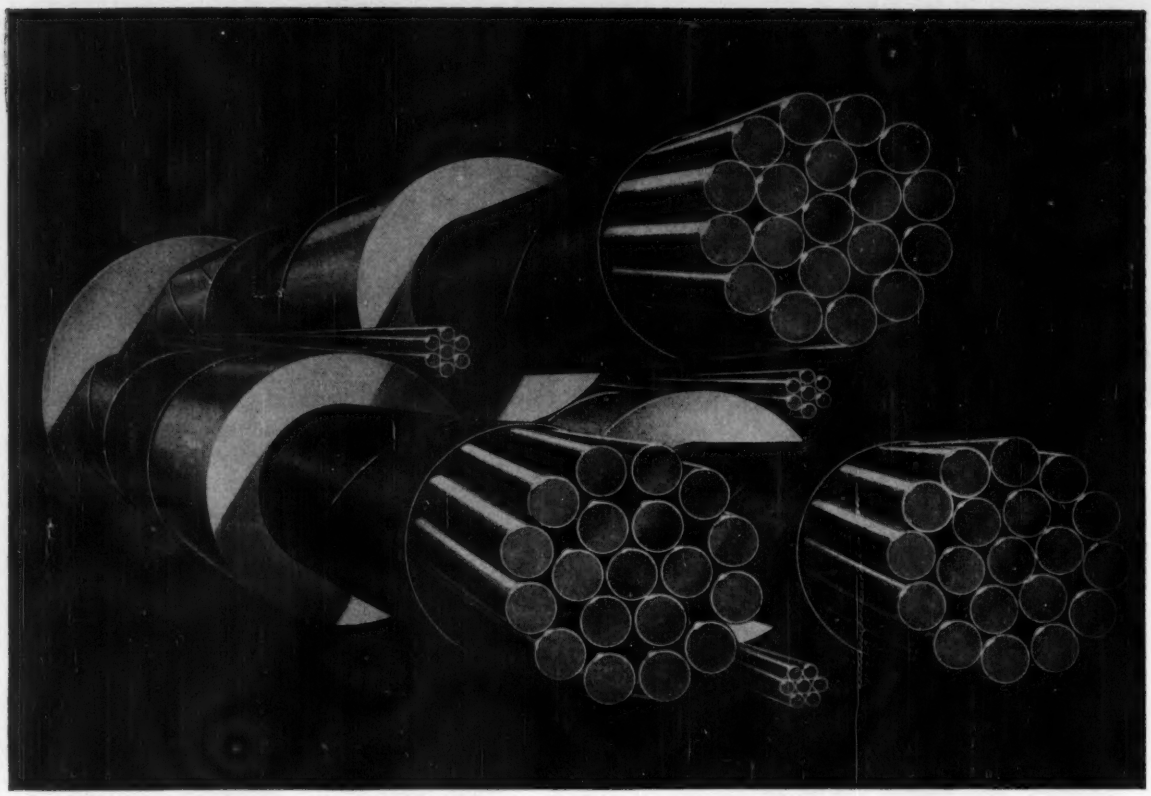

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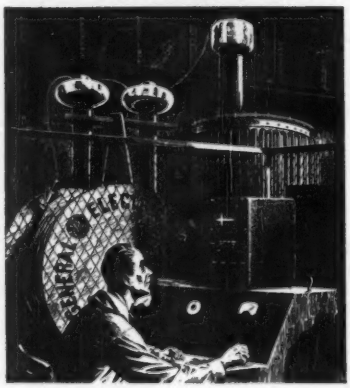

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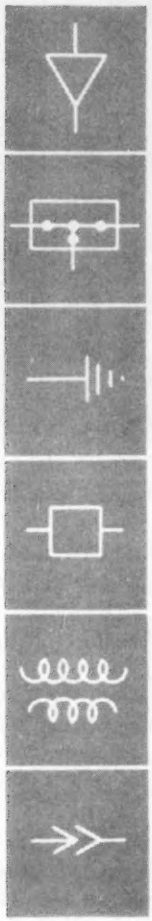

ENGINEERING

ITS ULTIMATE OBJECTIVE

By H. P. Sedwick, Executive Vice President of Commonwealth Edison Company of Chicago and President of its Public Service Company Division.*

It seems to me the current emphasis on the shortage of engineers may result in creating too great an evaluation of engineering education as an end rather than a means. Those of us who have had long experience know that the greatest personal satisfaction of being a member of the engineering profession comes from those opportunities of being helpful to our associates and our communities.

The individual engineer's ability that breaks through existing barriers of knowledge produces for him, of course, an adequate reward for the efforts expended. But the greatest satisfaction comes from being a member of a team which carries on to broader goals than the individual may hope to attain.

This leads me to the conviction that each of us in the engineering profession, particularly those who have had long experience, can well afford to consider whether he is devoting a fair share of his time and resources to constructive group activities.

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**Mr. Sedwick has spent his career in the electric and gas utility business. He is a former President of Western Society of Engineers; a Trustee of Illinois Institute of Technology; and member of the Board of The John Crerar Library.*

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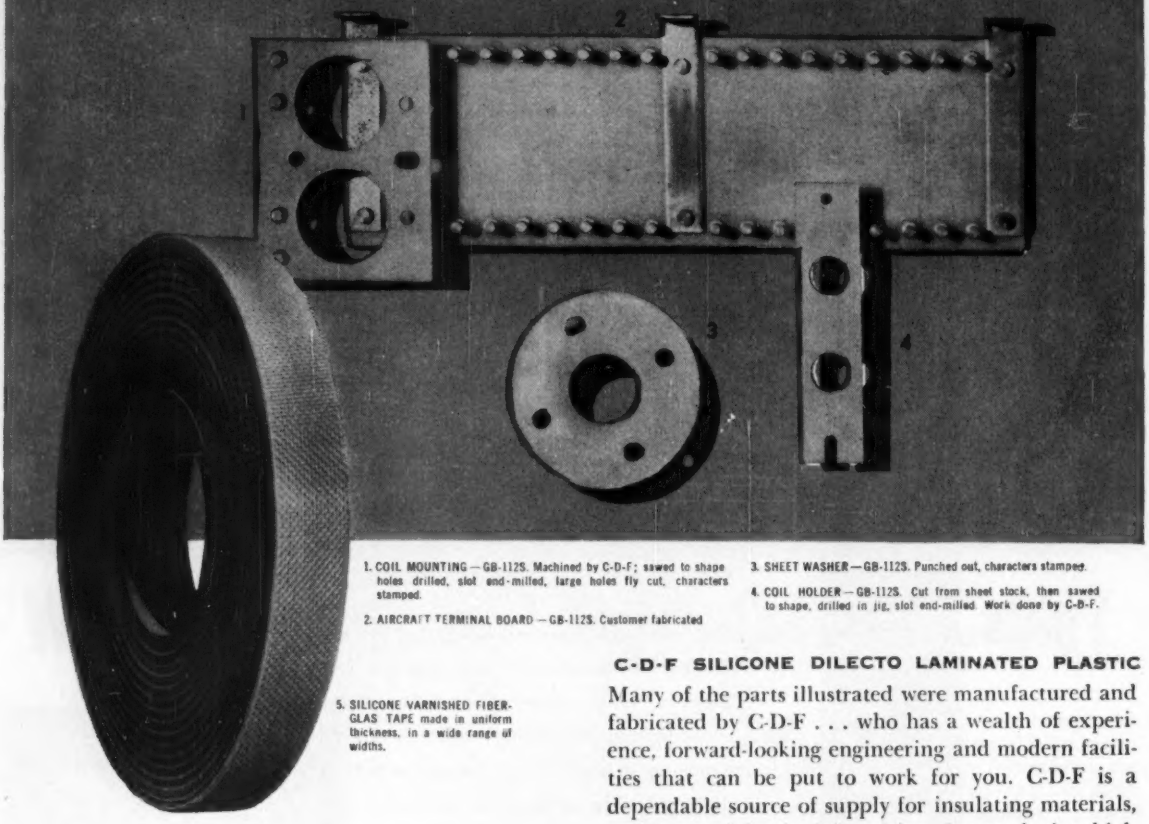

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What Is Your Opinion?

ABOUT mid-September you will receive a questionnaire from AIEE. It is not a long one; just middle-sized. There are 17 "yes-or-no, and this-or-that" answers to choose and check. It should not take 15 minutes. There is also an important blank space at the end to say what is left over, if the questions do not fully bring out your opinion.

The subject of the questionnaire is "Employment Conditions." It seeks, first of all, to find out some important facts about our membership: its age distribution, employment status, professional registration, distribution by types of employing organizations, and participation, if any, in collective bargaining. Then, it goes on to ask for expressions of opinion relative to various methods of communication between engineers and their employers on the broad subject of employment conditions. Finally it invites you to state any relevant opinion you may have on these subjects and the Institute's relation to them. The results will be tabulated, analyzed in various ways, and published.

Most electrical engineers are in a sense employees, even though their work is administrative or executive. Under certain laws they have to be classed as either employers or employees although there are all shades of administrative and supervisory work involved in the actual situation. This matter of classification presents a complex problem. Any law that has such broad sweeping provisions for including employees under collective bargaining as the former Wagner Act is likely to be an unhappy one for professional workers including, and perhaps especially for, engineers. The provisions for professional workers in the present Taft-Hartley Law are generally considered to meet better the needs of engineers, but they still need clarification and improvement. In any contemplated revision of this law, the position of the engineer as a professional man should be improved if possible and certainly not permitted to retrogress.

If the needs and desires of engineers are to be known to legislative bodies, engineers must be heard while legislation is being considered. To be heard, engineers must speak in sufficient numbers to be impressive. The only organizations that can at present speak for a cross section of the profession as a whole are bodies such as Engineers Joint Council (EJC), Engineers' Council for Professional Development, and National Society of Professional Engineers. Under EJC activity, two constituent societies, the American Society of Civil Engineers (ASCE) and The American Society of Mechanical Engineers (ASME), have already canvassed their members with questionnaires similar to the one you will receive in September. Others may do likewise, but ASCE, ASME, and AIEE together represent a total membership of about 125,000 which is between a quarter and a third of all engineers in the country. It is well established that reliable measures of fact and opinion are taken from much smaller samples than this.

Aside from this immediate need for an expression of engineering opinion in connection with legislation, there is the desirability of knowing the facts for ourselves as engineers, employers, employees, and independent consultants. Knowing more fully and accurately the facts about the employment status and the opinions of our members in these matters, should be helpful to all of us in finding the best solutions to our problems.

The data already in from the other societies and a small sample taken by AIEE indicate that a few engineering employees, by choice or otherwise, deal with their employers through unions. Some who do not, however, feel that this may be a desirable method. Others say that any form of unionism is incompatible with professional endeavor. There would appear to be a considerable number —we should know how many—of our members who believe that they have, in industry-type engineers' associations a broad technical scope but limited to a single area, community, or company, a satisfactory form of organization for studying economic questions, and for crystallizing and expressing opinion on matters of common interest and employment conditions. Half a dozen questions are included in our questionnaire to explore the extent of these associations, and the opinion of our informed membership as to this kind of relationship and communication among engineers with a variety of technical and administrative interests, and responsibilities.

The Lehigh Valley Section, which includes about 1 per cent of the Institute membership and covers a large territory with a variety of industries, co-operated with the Planning and Coordination Committee in a trial run of an earlier edition of this questionnaire. Seventy-five per cent of those addressed responded. On the basis of these test returns, the wording of some of the questions was revised for greater clarity. The questionnaire was then approved by the Board of Directors for distribution to the whole membership in continental United States. It may be that the results of this sample, which checked fairly well with the returns of ASCE and ASME, will not be too different from the final results returned by AIEE membership. That will be known only when the results are all in. The value of the whole project will depend on your prompt and thoughtful response.

In any event, it is to be hoped that the total percentage of returns will show as much interest and co-operation as did the Lehigh Valley trial. The returns from this trial brought many constructive individual statements as well as a high percentage of answers to the set questions. If you feel that AIEE has no business going into such matters, use the space provided at the end to say so. Your Board of Directors has no preconceived ideas on this subject. Naturally, they have personal opinions; but their objective as your representatives is to serve you effectively. To do this, they must know more about you, what you think, and what you want done. This questionnaire is your opportunity to establish a direct line of communication with your elected officers on a subject of major importance to our profession.

A Testimonial to H. H. Henline From Past AIEE Presidents

F. O. McMILLAN
FELLOW AIEE

A testimonial in appreciation of the services of H. H. Henline, who recently retired as secretary of the Institute, was presented during the Summer and Pacific General Meeting in the form of a portfolio of letters from Mr. Robertson and the other 15 living past presidents who served during Mr. Henline's tenure. The presentation was made by Past President McMillan.

DURING the past 22 years the AIEE has grown and prospered, notwithstanding the fact that during this period we suffered a major depression and fought the most devastating war the world has yet experienced. Obviously the outstanding success and growth of the Institute is not the result of the work of any one man, or any small group of men, but it has been due to team work with every member playing on the team. In this period 22 administrations have been inaugurated. However your attention is directed to one iron man on the team who has been playing every minute, Henry Harrison Henline.

As you know, Mr. Henline retired on June 1 (*EE, June '54, pp 487–8*) and unbeknown to him we have chosen this occasion for the purpose of expressing our thanks and appreciation for his 27 years of outstanding service.

The developments of the past 27 years, of course, are not the work of any one man or small group of men but all must agree that a very large part of the stability and continuity in the administration of Institute affairs has resided in the secretary. Fortunately he has been endowed with the wisdom of Solomon and the patience of Job and both of these attributes have been essential. Each new administration comes to office full of ideas and plans for revolutionizing the operation of the Institute. Some of these ideas are good, some are bad, and many have been tried previously and found wanting. The retiring secretary has had an uncanny, unobtrusive way of helping each administration to discover the pitfalls without imposing his own ideas or opinions. The latter were never given unless there was a clear indication that they were wanted. A few have criticized this policy, however, I believe I can say without fear of contradiction that all of us who have been honored by election to the presidency of the Institute during Mr. Henline's tenure of office believe that his wholehearted co-operation and the lack of dictation and domination in administrative affairs has been one of the great factors contributing to the growth and general well-being of our Institute. This conclusion is supported by letters from President Robertson and each of the 15 living past-presidents who have served with Mr. Henline. May I give you some brief but typical excerpts from them?

Harry P. Charlesworth, President, 1932–33

"Your period of administration has indeed been a remarkable one considering the critical periods through which our country has passed and the marvelous growth which the Institute has experienced.

"On such an occasion, I am sure you cannot but take a great deal of pride and satisfaction, as your friends and associates have done so often, in your many accomplishments and in the great contributions you have made to the Institute, in itself and in its relations with other engineering societies.

"I have followed these outstanding achievements with particular interest and pleasure for it was during the time I was president that our Board of Directors asked you to serve as national secretary."

Dr. J. B. Whitehead, President, 1933–34

"To have kept things on an even keel during the vast increase of detail and activities passing over your desk, is indeed a tribute, not only to your efficiency, but to your sense of tact and your personality."

William H. Harrison, President, 1937–38

"My association with you began when you came with the Institute and I know first hand of how much you have helped its growth and its service to the membership. You also made the high office of president a most enjoyable one by handling the many burdensome yet important day-by-day matters and by sound advice."

F. Malcolm Farmer, President, 1939–40

"My years of active participation in Institute affairs, specially during my term as president, brought me into rather close contact with you. I was always impressed by your meticulous handling of the many details of your job, the responsibilities of which have grown so in recent years."

Dr. Royal W. Sorensen, President, 1940–41

"Well do I remember, you the man behind me, because you did so much to make whatever success I had during my active years aiding in the conduct of the affairs of the Institute. The friendship you showed then must have stood the test of time so you continued even unto this day to regard me well, otherwise I would not have been given the great honor that has just been given by the Institute."

David C. Prince, President, 1941–42

"You performed yeoman services, as I recall it, in spreading the gospel of postwar planning which was certainly—

Essential text of an address given at the AIEE Summer and Pacific General Meeting, Los Angeles, Calif., June 21–25, 1954.

F. O. McMillan, AIEE past president for 1951–52, is with Oregon State College, Corvallis, Oreg.

at least partially—responsible for the fact that at the close of the war we had not 8,000,000 unemployed, anticipated by Mr. Truman, but rather overemployment which has lasted almost to the present day."

Dr. Harold S. Osborne, President, 1942–43

"I think that you must find a deep satisfaction in the progress which the Institute has made during these 27 years. Not only has it grown tremendously in numbers but in scope and importance of activity. The organization has continuously been modified to serve the needs, and throughout all this period, in good times and bad, the Institute has maintained a very solvent financial condition.

"We who have been associated with the management of the Institute know that you have contributed in important ways to all of these aspects of progress. I give you my hearty congratulations, and as a member of the Institute my deep thanks for your important service to it."

Nevin E. Funk, President, 1943–44

"Anyone who has had the honor of being president of the Institute, cannot but appreciate how much help he has received from yourself and the splendid organization you have developed at headquarters. Except for this, I am sure much of the work of the presidency would not be a physical possibility for most men. I, therefore, wish to take this opportunity to thank you personally for the help you were to me during my tenure of office, and to extend to you my best wishes for a long and happy retirement."

C. A. Powell, President, 1944–45

"The notices in the technical press of your retirement turned back the clock to the days when I had the pleasure of close association with you in the running of Institute affairs. I hope you enjoyed that period as much as I did, and since we must now perforce learn to loaf, I hope our paths may cross frequently so that we can compare notes on the art of loafing."

J. Elmer Housley, President, 1946–47

"It is with a sense of real personal satisfaction to be able to express my appreciation for your great service to the AIEE, its membership, and the profession.

"Since joining the Institute in 1919, I have marveled at its growth and value. Such growth has been due in considerable measure to your wisdom, understanding, and untiring efforts. It is also a pleasure to pay tribute to Mrs. Henline for her fine spirit."

Everett S. Lee, President, 1948–49

"It is with many happy memories that I write you. Throughout your years of outstanding contribution to the AIEE and to the profession you were most helpful to me in ways which I always appreciated beyond measure.

"Throughout your long period as secretary of AIEE you saw the Institute grow into many new avenues, and you were instrumental in guiding the Institute into this growth to outstanding advantage. As you look back upon your years of service you can feel honored in your contributions."

James F. Fairman, President, 1949–50

"Again, I wish to express to you my very great appreciation not only for your assistance to me at all times and more especially during my term of office but also for what you have done for the organization and its members through your courteous and efficient service as secretary of the Institute. You may be justly proud of that service and I am sure you will find lasting satisfaction in recalling it during the years ahead."

Titus G. LeClair, President, 1950–51

"A year of service as president gave me the opportunity to see how well you filled your responsibilities. Handling the headquarters staff organization is in itself a major management responsibility. In addition, you have that fortunate ability to interpret both the spirit and the letter of the policies laid down by the Board of Directors and officers rather than imposing your personal views in carrying out the Institute work. This approach to your duties as secretary has had much to do with the ability of the Institute to change its policies and methods of organization to keep up with the changing conditions, and consequently to build up its strength and influence in the profession."

F. O. McMillan, President, 1951–52

"Your singleness of purpose in seeking out and doing those things that were best for the Institute has made a great contribution to the success and growth of the society, and to the welfare of the electrical engineering profession.

"I am personally deeply indebted to you for the assistance and many courtesies you have extended to me during my participation in Institute work and particularly for your help during the year I served as president."

Donald A. Quarles, President, 1952–53

"The word 'secretary' has many connotations, as I am beginning to learn, but in the case of AIEE it has had a very special meaning during the quarter century or so of your incumbency. I know, from the year in which we were so closely associated and from the many years in which I have looked to you for help and guidance, what a tremendous service you have rendered the Institute and how much all of its members are indebted to you for what you have done."

Elgin B. Robertson, President, 1953–54

"I hope you realize the importance of your own contribution to the development and growth of the Institute. I want to tell you that all of us owe you a debt of gratitude that we will never be able to pay.

"Those of us who were fortunate enough to know you well have received from you not only help and guidance, but also stimulation toward further effort. I for one would like for you to know how much I appreciate your counsel and guidance, but most of all I appreciate the friendly way in which it was given. I'm proud, my friend, to call you 'friend.' May the good Lord give you many years in which to enjoy the good things of life and for others to enjoy and benefit from this comradeship with you."

Henri Frederick Amiel the Swiss essayist, philosophical critic, and poet has said: "To know how to grow old is the masterwork of wisdom and one of the most difficult chapters in the great art of living."

Those of us who know the Henlines are confident this chapter of their lives will continue to be, as those in the past have been, one of service and devotion to high purposes.

The Year's Achievements

ELGIN B. ROBERTSON
FELLOW AIEE

At the end of the 1953–54 administrative year, Mr. Robertson discusses some of the activities of the Institute, and of the engineering profession in general, during his term as AIEE president.

AS ANOTHER Institute year draws to a close, it has become the custom for the outgoing president to examine the accomplishments—and problems—that have marked his term of administration. In the following report to the membership, I shall try to cover some of the highlights of my presidential year.

First, the financial situation of the Institute is, in my opinion, in a satisfactory condition—in spite of the fact that we expended $6,100 more than we received as of April 30.

The Institute, of course, has three different years: the fiscal year ending April 30, the administrative year ending July 31, and the budget year ending September 30. For the present budget year, increased services to the membership have been provided for. I think this is where the membership wants our money spent. However, with increased services and a continually expanding membership, when the next budget is prepared our financial situation will have to be re-examined carefully.

AIEE membership continued to increase during the year, and now stands at almost 48,000. This is an impressive figure and represents a considerable increase but still leaves the 50,000 mark for the future, although the Institute continues to be the largest engineering society.

The Student membership is one item to which the administration can point with pride. Ever since 1950, Student membership has been decreasing, chiefly because of the drop in enrollment in the colleges. This trend has been reversed this year, in spite of the fact that this year's graduating class is smaller than those of the preceding years. A lot of thought and effort have been devoted to the situation, which has resulted in a substantial increase in Student membership.

Technical activities continue to be the chief concern of the Institute. They are our reason for being. That these activities are not being neglected is attested by the fact that the year set new records for attendance at meetings, for the number of sessions held, and for the number of papers presented. The reports of the committees in the "Report of the Board of Directors" (*pp 755–82*) is a fascinating and interesting story of progress.

Publications of the Institute represent approximately 50 per cent of total expenditures. For the fiscal year just ended, we published the largest number of papers and the most pages in our history. In *Electrical Engineering* the "Current Interest" and "Institute Activities" sections have been increased considerably, and more space will be devoted in the future to "Student Activities," to provide more items of interest in student matters.

Use of the bimonthly publications has increased about 20 per cent. Surprisingly, this has not cut down on the demand for the *Transactions*. In fact, the 1954 *Transactions* printing will be increased considerably.

"Conference papers" represent roughly 60 per cent of the papers presented. In the past these papers have not been published by the Institute as the technical program papers have. The problem has been how to make conference papers available, particularly to those unable to attend the sessions where the papers were presented and at which a limited supply was usually furnished by the authors.

The Publication Committee has recommended that we publish and make available all conference papers which are received from the authors 60 days in advance of presentation. This will make the papers available prior to the meeting, at the meeting itself, and after the meeting. This recommendation has been approved, and will be in effect starting with the Winter General Meeting in 1955. It is to be hoped that this will be a satisfactory solution to an old problem because the plan will considerably increase the publication costs of the Institute.

A NEW ENGINEERING CENTER

THE PRESENT building in New York City housing the engineering societies is 50 years old, and has been inadequate for several years. The AIEE is now renting space in an outside office building at considerable expense. There has been talk about the inadequacy of the building for some time, but nothing really was done about it until a concrete proposal was made by Treasurer W. J. Barrett showing how a suitable building can be built without the aid of another Andrew Carnegie.

The United Engineering Trustees (UET) has devoted itself to this problem diligently, and has done a lot of work and gathered a great deal of information. UET is composed of the four Founder Societies, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and AIEE. The American Institute of Chemical Engineers also want to take part in the new building, and it is hoped that others will come in later so that we will truly have an Engineering Center.

The April meeting of the AIEE Board of Directors was held in Chicago, Ill., and we invited the boards of the other four societies to meet with us on the day before our

Full text of an address presented at the AIEE Summer and Pacific General Meeting, Los Angeles, Calif., June 21–25, 1954.

Elgin B. Robertson, AIEE past president (1953–54), is president of Elgin B. Robertson, Inc., Dallas, Tex.

Board meeting to inspect the sites available in Chicago and to hold a joint meeting at which we could decide on a future course of action leading to a decision.

At the joint meeting 48 representatives of the five societies were present, including all five presidents. After considerable discussion, this meeting recommended to the boards of the societies that a committee be formed, consisting of the present five presidents, for the purpose of expediting the determination of a suitable location and other questions necessary for a joint decision by the boards of the five societies relative to providing an Engineering Center building.

It was felt that here we would have an agency including the societies in UET, as well as those not in UET, and one which could bring us one step closer to the final decision. This Committee of the Five Presidents has now been authorized by all of the societies, and it is hoped that a decision can soon be made.

Elgin B. Robertson

PROFESSIONAL UNITY

At the 1953 Summer General Meeting I promised that I would do whatever I could to further the cause of what we term "unity of the profession." I said that I had no particular plan to sell, that I would support any plan that had the support of a majority of the individual members of the profession, that I did not believe that any other plan had a chance to live. This still represents my views on the question.

What has happened during the year just passed? First of all, the matter of professional unity has had continual and serious study throughout the year. Last fall a committee from the Board of Directors was appointed to study the progress that had been made and to make recommendations for future action. This committee made its report at the January meeting of the Board, and its recommendations, as approved at that meeting, were that the Engineers Joint Council (EJC) be asked to develop a plan for unity (1) based on individual membership, (2) vested with power to act promptly, and (3) provided with a sound plan for financing. Our representatives on EJC were instructed by the Board to advise the Council of the seriousness with which we view the need for real unity, and to work toward implementing the recommendations of the committee.

In March, the Council voted to recommend the establishment of a voluntary dues-paying individual membership, but without a direct vote. At the April meeting of the Board in Chicago, we said that this was not enough and we asked the Council to consider the plan published in *Electrical Engineering* (*EE, Apr' 53, pp 349–51*), a plan which we felt had merit and one which came close to that which our members have said they want.

This is the present status. Our future action will be governed by the action of the Council on this proposal.

Engineers want and should have recognition for their contributions to the welfare of mankind. They want to be recognized as a profession. How to accomplish this is the problem that confronts us.

In some of the proposals that have been made there is wishful thinking; in others some actual loose thinking.

The matter of unity is a complex problem. It means one thing to one person, and something else to another; a profession to some, a pressure group to others. These two are not synonomous. A lot of people are involved in coming to an agreement. We must recognize that each point of view is championed by people who are just as sincere in their belief that their idea is best for the profession as we are in our own beliefs. We have, therefore, tried sincerely never to get into a position where it was felt that we would only play on our own terms, or that we were not willing to give as well as take.

Too many think that if we had the right organization, all our problems would be solved. They see the high professional standing of the medical doctor, and they think that the American Medical Association (AMA) is responsible for it. Nothing could be further from the truth. No profession can be better than its individual components.

Each doctor has his own ideas on technical skill, on ethics, and of personal conduct. If each followed his own ideas, there would be no standard by which we could gauge their ability. We would have confidence in Dr. Brown, with whom we had had personal experience, but Dr. Smith, whom we do not know, would be to us an unknown quantity and we would hesitate to call on him when we needed a doctor.

Doctors organized in AMA and set certain standards for educational preparation, for preprofessional experience, and for personal conduct. These standards are high, are in the public interest, and are well known. Doctors conform to these standards, and as a result we have confidence in them and in their competence.

It is not the license that is issued to the doctor that has brought this about. Licenses are issued to cut hair, to install plumbing—or to operate a bar.

Neither will the license issued to practice engineering create an engineering profession.

We must have standards of attainment and practice, must devote ourselves to the public welfare and live up to these standards. And what is still more important, these standards must become widely known and recognized.

THE INDIVIDUAL AND THE GROUP

Others think that through group action, we can raise the economic level of the profession and thereby gain recognition.

I am not opposed to unions, as such. I have seen men taken advantage of in large industrial plants, and the union is about their only means of defense.

But because unions have been successful for industrial workers does not mean that they are good for intellectual workers such as engineers. Let us look at some of the fundamentals of unions: Individuals are lost sight of—the group is the unit. Pay and working conditions are set for the group. For those of average or below average ability, there is a distinct advantage. For those of better than average ability, there is a loss, for they are pulled down to the average. All incentive to become a better workman is lost.

Do you see what will happen to engineers if they act and are treated as a group? (1) Individual initiative will be killed. (2) A levelling of pay will take place. (3) There will be no individual advancements or recognition of individual achievement. (4) Professional status will be impossible.

We need individually to look squarely at some basic facts. Our profession is radically different from those of medicine and law. The direct personal aspect which is nearly universal in the medical and legal fields has only a limited counterpart in engineering. Our people have interests covering a vast range, from research and development to business management, and with many as employees.

I believe that a profession is made up of individuals, and I further believe that professional responsibility is as personal as one's toothbrush.

I further feel that the real basis of the profession is the local unit, for here is where the selection must be made as to membership. True, a profession must have a voice at the different political levels, that is, county, state, and nation. The state organization should concern itself with the problems that encompass more than one local unit, and the national organization should be concerned only with the problems that are nation-wide in scope. In other words, I look on both the state and national organizations as co-ordinating agencies, rather than policy-making bodies.

If the local unit cannot get recognition and respect in its own community, then how can we hope to gain state-wide or nation-wide recognition and respect? Let us start by practicing unity in our own home towns. Let us act as professional people.

This means, in simple terms, that each one of us must do his part. We should not expect someone else to do for us that which we are unwilling do for ourselves. Are we willing to pay this price in order to have an engineering profession?

IN APPRECIATION

A year ago I said that we would need a lot of help from a lot of you, but that I knew that help would be forthcoming as needed. This was an accurate forecast. I have not been turned down in a single instance that I can recall. The men of AIEE simply do not say "No." They accept their responsibilities.

I want to thank my associates on the Board of Directors and the Headquarters staff for their sympathetic understanding and generous co-operation and help.

The entire membership of the Institute contribute toward making the experience of being president the most wonderful that can come to any man. I have enjoyed it tremendously.

I suppose that every president feels a sense of frustration when his term of office comes to an end and he sees so little accomplished and so much to be done. It is probably a good thing that we change slowly and spend most of our energy on stimulating interest and participation in the affairs of the Institute. In any event, here is one president who has no regret at stepping down, for I know that the following president will carry on to even greater success.

In conclusion, I would like to quote from Article 29 of the Articles of Association of the Japanese Institute of Electrical Engineers: "The person who was once the president should be treated well as the ex-president."

X-Ray Diffraction School

North American Philips Company, Inc., and its western dealers will hold the Second Western X-Ray Diffraction School in San Francisco, Calif., August 30 to September 3, 1954. The West Coast school is held annually to accommodate scientists in the area who asked the company to duplicate the program held semiannually in the New York, N. Y., territory during the past 8 years.

No registration will be charged and those who wish to attend are urged to register as soon as possible with Philips dealers or any North American Philips Company office since accommodations will be limited. School participants should make their own hotel reservations or could ask Philips to handle the matter.

Morning sessions of the school will be devoted to lectures and afternoon meetings will involve laboratory demonstrations using the latest types of equipment. This work will cover powder camera techniques, the X-ray Diffractometer techniques, and X-ray Spectrograph techniques.

On Friday, September 3, the school will devote the day to actual application problems from the field and speakers will discuss details of methods currently in use in industrial laboratories and plants.

Attendance at the East Coast school in April 1954 was 200 and West Coast registration is expected to be equally large. Several units of each type of equipment will be provided to accommodate the needs of all who attend the West Coast school.

Unbalance of Twin-Conductor Lines

E. T. B. GROSS
FELLOW AIEE

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INDUCTIVE AND CAPACITIVE unbalances are present in transmission lines which are not transposed. Because of the expense and inconvenience involved in making transpositions, it is often desirable to omit them. This is especially true of twin-conductor lines which have certain advantages at extra-high voltages. When transpositions are omitted, it is desirable to compute the resultant unbalance. Considered here is the electrostatic unbalance to ground which is a result of unequal capacitances between the conductors of the three phases and ground. The basic conductor configuration is shown in Fig. 1.

In an ungrounded system, electrostatic unbalance results in a displacement of the system neutral from ground potential. The ratio of the magnitude of the neutral displacement voltage E_0 to the magnitude of a phase to neutral voltage is defined as "unbalance factor" d_0 and expressed in per unit or in per cent.

$$d_0 = \frac{E_0}{E_{phase}} \tag{1}$$

In a solidly grounded system, the unbalance manifests itself as a fundamental frequency, zero sequence current $1/3I_u$ in the system neutral to ground connection. The following relation exists:

$$d_0 = \frac{I_u}{I_{GF}} \text{ where } I_{GF} = \frac{3E_{phase}}{X_0'} \tag{2}$$

X_0' is the capacitive zero sequence shunt reactance of the system. Either of equations 1 or 2 may be selected to compute d_0. Using equation 1 and the known relationships between conductor potentials on a 3-phase transmission line of the ungrounded system, a general expression for d_0 can be derived for the configuration of Fig. 1 in terms of the physical dimensions of the configuration.

Since the outer phases of the conductor arrangement are symmetrically equivalent, they must have equal capacitances to ground, and any unbalance is due to a different phase-to-ground capacitance of the center phase. Changing either the heights or the intraphase spacing of the center phase conductors should change the unbalance. The general expression for d_0 was used to plot the curves of Figs. 2 and 3.

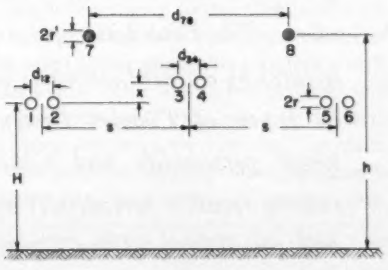

Fig. 1. Generalized conductor configuration

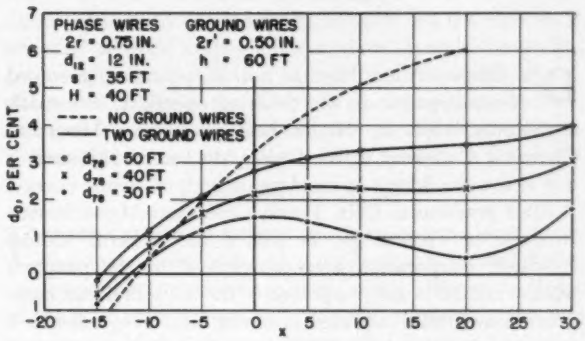

Fig. 2. Effect of ground-wire spacing on unbalance

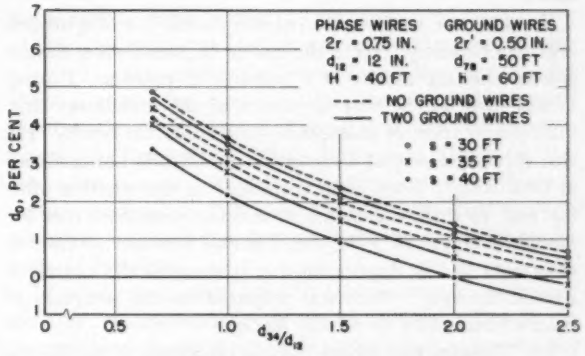

Fig. 3. Effect of phase spacing on unbalance

Fig. 2 illustrates that lowering the center phase effectively reduces d_0, while raising the center phase, in general, does not have a favorable effect. Fig. 3 shows that complete balance can be achieved by increasing the spacing of the center-phase conductors to about 2.5 times the spacing of the outer-phase conductors. The presence of ground wires and changes in other dimensions of the configuration also have some small effect on d_0.

The practicality of reducing unbalance by lowering the center phase may be questioned. Because of minimum allowable ground clearance, this change would require increased tower height, resulting in increased cost. However, it appears that the unbalance could be greatly reduced or even eliminated by variation of the intraphase spacing of the center-phase conductors without affecting the tower design or requiring any other major changes in the line construction.

Digest of paper 53-401, "Electrostatic Unbalance to Ground of Twin-Conductor Lines," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Kansas City, Mo., November 2–6, 1953. Published in AIEE *Power Apparatus and Systems*, December 1953, pp. 1288–97.

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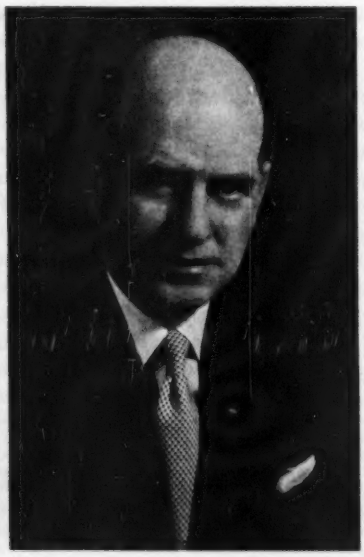
The 26th
Steinmetz Memorial Lecture

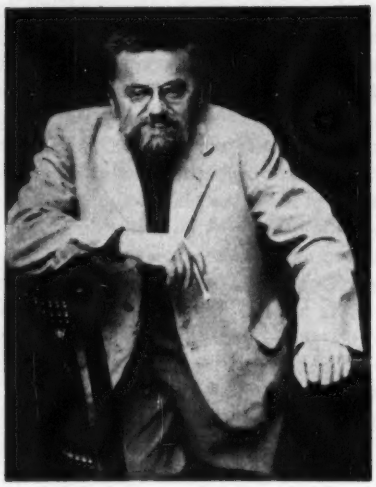
DR. Charles Allen Thomas has an outstanding record of achievement in the fields of chemical, industrial, and atomic research. He has been president of Monsanto Chemical Company in St. Louis, Mo., since 1951 and is one of the key figures in the development of atomic energy.

After graduation from Transylvania and Massachusetts Institute of Technology, he joined the General Motors Research Corporation and contributed to the program which resulted in the production of the tetraethyl lead compound now commonly used in motor fuels. He was also a research chemist with the Ethyl Gasoline Corporation and one of the organizers of the Thomas and Hochwalt Laboratories.

Dr. Thomas' early work centered on the line of synthetic organic chemistry. He is the author of numerous scientific papers and the holder of a number of patents. During World War II, he was in charge of the metallurgy and final purification of plutonium for the atomic bomb. He was appointed project director for the Clinton Laboratories at Oak Ridge, Tenn., and continued in this position after the war, as work was begun to develop peacetime uses for atomic energy. In 1946, Dr. Thomas was one of the five coauthors of "A Report on the International Control of Atomic Energy," which was prepared for the Secretary of State's Committee on Atomic Energy.

Dr. Thomas has served also as chairman of the Scientific Manpower Advisory Committee of the National Security Resources Board, and was appointed consultant of the National Security Council in 1953.





DR. CHARLES PROTEUS STEINMETZ
1865–1923

MEMORIAL FOUNDATION

IN consideration of the outstanding technical and scientific ability possessed by Dr. Steinmetz, and of his broad human interests and varied activities, the Steinmetz Memorial Foundation was established in 1925. By subscription among his many friends and admirers, a fund was collected and placed in permanent trust under the administration of the Schenectady Section of the American Institute of Electrical Engineers. The Foundation provides for public lectures by eminent scientists and engineers, in honor of Charles Proteus Steinmetz, whose personality and achievements will thus be recalled periodically by the delivery and publication of the Steinmetz lectures.

Science, Progress, and the Human Mind

CHARLES STEINMETZ was a man whose professional accomplishments have become a permanent part of the history of science. He was a man with enormous professional stature—yet, a man whose personality contained enough warm, mischievous human quirks to make us remember him with frequent chuckles.

Steinmetz was a most unusual man. Although he was an intense specialist, his mind was not fenced in by his discipline; his thinking and his interests ranged far beyond the concepts of his profession. Steinmetz was a humanist as well as a scientist. Neither his practical success nor his absorption in his work prevented his mind from concerning itself with a variety of human problems. We have written records of his thoughts, his comments on matters unrelated to his science. In the breadth of his interests perhaps he has set an example for us all.

The theme of this meeting, "Engineering, the Pillar of Progress," expresses an intriguing thought; it is a well-phrased statement of fact. A pillar in proper use is a support—functional first, yet beautiful in its very usefulness; valuable because of its purpose. Supports, however, must be balanced, must be set on solid foundations for the edifice to be sound, firm, and enduring.

And so it is with the progress of mankind, the march of civilization, which this theme symbolizes as a building supported by practical applied science. However, in our preoccupation with the foundations, we must not lose sight of their purpose, nor should we be misled into thinking the pillars are the edifice itself.

SCIENCE AS A PILLAR OF PROGRESS

I BELIEVE we can all accept the premise that the progress of humanity, the advance of civilization, must be gauged by a number of facts. Since man himself is doing this evaluation he must assess them on a personal basis. Mankind's progress is essentially the individual's progress toward personal freedom, toward peace of mind, toward material security, toward tolerance and open-mindedness, toward self-government that permits rational self-determination. To the extent that science serves these ends, it is indeed a pillar of progress.

Let us therefore examine a few facts of familiar experience and consider how well science has served these ends.

It would be invalid to assert broadly, without qualification, that all applied science has been good for humanity. It would be equally invalid to say—as too many poorly informed, frightened people are saying today—that science is forcing civilization to the brink of destruction. Both of these statements, because of their generality, contain a welter of truths and falsehoods. Our analysis of progress will have to be much more delicate. Our assay of achievements should have, somewhere in its criterion, common needs and desires. We will then inquire: how balanced is the edifice of progress? How well is man integrating progress in science with his own progress—toward a human ideal? Is true progress being made, or are the pillars creating stresses and strains in the building? We can answer these questions by examining the impacts of a few aspects of scientific progress as they affect modern man economically, psychologically, politically. If we analyze some of the effects of scientific progress in their proper context, we may find some reason to question whether our edifice of progress is being constructed in the best possible manner.

The 26th Steinmetz Memorial Lecture, delivered by Charles Allen Thomas at the meeting of the AIEE Schenectady Section, May 6, 1954.

ECONOMIC PROGRESS

ECONOMICALLY over the past two decades there is no question that applied science has made almost immeasurable contributions to mankind's material needs. The technology of mass production has been largely responsible for the highest standard of living in the world. Between 1939 and 1949, the median wage of Americans rose 156 per cent, from $789 to over $2,000. Despite inflation the average rise in real income was about 50 per cent.

This represents an enormous increase in purchasing power, in consumption, in better living for more people. What is particularly astonishing is that in 1952 the total number of man-hours worked in our economy was approximately the same as in 1928. If we ask: How was this enormous increase possible? . . . the answer may be found in another statistic: in 1928 there were 200,000 engineers employed in the economy—or approximately one engineer for every 100 workers.

In 1953, there were 400,000 engineers or an estimated ratio of one engineer for every 40 workers. This is the average for industry as a whole. Some industries employ as few as ten workers per engineer, some as few as five.

In 1929, a year of great general prosperity, the gross national product was somewhat below $104 billion. In 1953, it was close to $350 billion. Even with the inflated dollar, this is a large increase.

This effect upon our economy has largely been the result of applied science put to work. The tempo of innovations today is increasing. Where 20 years ago a large percentage of industrial management resisted change of methods, today, most are actively seeking improved technology. Industrial progress is no longer by chance or by inspiration; it is an established function, as entrenched as sales and production.

Under the impetus of World War II, technology was responsible for an astounding increase in our nation's productivity. The war presented our nation with the problem: How with X number of man-hours, can we produce Y amount of materiel? The amount of materiel was fantastic. However, applied science and engineering solved this problem, developed advanced methods of mass production, and continued over the past decade to perfect the new devices and techniques.

MECHANIZATION OF INDUSTRY

THE profound change in manufacturing methods that is is in process required a new word, so a term was

coined: automation—to describe with a single word increasing mechanization of industry.

Who realizes as well as these readers that a new era of production is already well started—the age of the automatic factory, servomechanisms, and mechanical brains. These are triumphs of applied science which the engineers of the past 2 decades have brought into existence and have already developed to an astonishing degree of perfection.

These achievements of applied science—ranging from the simple servomechanism that opens a garage door, to the complex electronic computor with a memory and a mechanism for self-checking—predict economic and social changes that can as yet be hardly realized. And they are already becoming part of everyday practice.

In Cleveland, Ohio, the Ford Motor Company operates an entire engine plant that is virtually run by machines; in Buffalo, N.Y., an automatic body parts plant; and in Dearborn, Mich., 11 automatic production lines.

In some food packaging plants, sheet metal for cans, corrugated board for cases, and food to be canned are fed into an automatic machine that makes the cans, fills them, and turns out the sealed, labeled, packed cases at the end of the line.

Chrysler's Firepower *V-8* engine is assembled automatically and Chrysler has two automatic crankshaft forging lines. All of us are familiar with the automatic manufacture of light bulbs, glassware, candy bars, and radio subassemblies.

Automation is invading purely service occupations. We are all familiar with the way in which American Airlines handles plane reservations with a device called the Reservisor.

The Bell Telephone System, with the help of General Electric, has made enormous strides toward automation since the end of the war. The company is working on a long-term program that ultimately will enable the user to dial calls across the continent as easily as he dials a local call. The development of the coaxial cable, originally with 480 voice channels, has now been expanded to carry 1,800. You are much more familiar than I with the valuable work being done with microwave developments in the field of communications.

Messrs. Leaver and Brown recently wrote: "Already we have machines that see better than eyes, calculate more reliably than brains, communicate faster and farther than the voice, record more accurately than the memory and act faster and better than hands. In every department of nonemotional thinking, machines can be built that are superior to workers on the same job."

There are vast engineering problems to be solved before automatic production devices make really heavy inroads on factory employment. But the developments of the past few years show that applied science is forcing the start of another transition in working habits, individual skills, and types of employment. In the long run—as with the automobile, the punch press, and the loom—the workingman will find fields of employment unknown today.

Meanwhile, what of population?

The decennial census of 1950 showed that from 1940 to 1950, the United States experienced the greatest population increase in its history. According to the count, our population rose 19 million in the decade. In 160 years, the population of the country increased 39-fold. This represents a growth unprecedented in human history. The total population doubled five times. The first three doublings took 25 years each; the fourth, between 1865 and 1900, took 35 years; the last doubling, between 1900 and 1950, took 50 years.

The largest factor in our latest population increase was the excess of births over deaths. Yet despite the bumper annual crops of babies, the median age of the population rose from 29 to 31.2 years, the highest ever recorded for the American people. While the total population was doubling in the first half of this century, the number of people 65 years of age and over quadrupled; these over-65 people today aggregate over 8 per cent of the population.

The large numbers of people of greater age may have an important influence in molding public opinion in the years ahead. More mature people are less impressed with material things alone; other values come into clearer focus.

A few years ago, Warren S. Thompson of the Scripps Foundation for Research in Population reported a surprising fact: that prior to 1750, there was very little difference in the manner of life of all civilized peoples. The methods of cultivation of crops and the care of the soil and the general productivity were on a comparable scale everywhere, in England, Italy, France, Asia, and in the New World, with the probability that China was slightly more advanced. So, too, were the concepts and practices of sanitation, public health, and the control of disease.

But the middle of the 18th century saw the slow birth of modern science and its applications. From that time to the present the nations that have applied scientific technologies have made spectacular gains in providing materials of subsistence. In 1700 it took the labor of four European families to produce the food and fiber required for five families. In Russia, this was still true 25 to 30 years ago; the ratio still persists in China and Java today. In the United States, however, one farm family produces enough for six families at a greatly increased level of consumption. It is reasonable to estimate that on an equal consumption basis a single American farm family today produces enough to supply ten families at the level of subsistence in 1700.

SCIENCE AND HUMAN PROGRESS

The application of science to public health facilities: sanitation, water works, sewage disposal, medical research, hospitals, personal hygiene, and preventative medicine, has controlled perennial epidemics. Typhoid, diphtheria, cholera, smallpox, dysentery, in our country, have been largely eliminated. These material goods are unquestioned contributions.

I have touched briefly upon these familiar examples of technological progress in order to draw up a series of parallels.

The collective technologies that increased the productivity of the soil were hailed as progress not because they kept a man's stomach full, but perhaps because this coercion, taming, and manipulation of nature gave man a greater sense of security in his environment.

The applied engineering science that created sanitary cities, disposed of sewage, drained cesspools and swamps was identified as progress; not because of the ingenious, efficient handling of pipes, pumps, and concrete, but because it made day-to-day living pleasanter, more enjoyable.

The advances in personal hygiene are not counted in the score of civilized achievements because chemists were so clever as to make good soap and detergents so cheaply; but perhaps because cleanliness improves man's sense of well-being.

And the conquest of typhoid, cholera, and smallpox are claimed neither because their control is a fabulous triumph of medical logic; nor because their conquest leaves behind much pleasanter ways to die. Control of these epidemic diseases freed man of their fear, gives him greater hope for longer life.

Modern science has been identified with human progress because it returned values dear to the human spirit: security, a sense of well-being, enjoyment, hope.

SHOCKS TO MAN'S EGO

Concomitant with applied science's history of contributing remarkably to man's physical needs, we cannot help but admit, and show commiseration for, the shocks science has dealt man's ego.

Consider medieval man, secure in his belief that his flat earth was the center of the universe, that the sun and the stars circled his habitation.

Successively, science proved to him that his earth was not flat, but round; that the sun and stars did not circle majestically around it, but in fact his round world circled the sun. Then, not to leave the cup half-full, science made it clear that the sun, although many times larger than the earth, was itself quite insignificant in the galaxy; and there were millions more suns, all larger, brighter, more majestic.

What a profound shock to man this sudden shrinking of his place in the universe must have been. Perhaps it was a blessing that the communication of news and knowledge was so primitive that even after the discoveries, generations lived and died without being disabused of their more comfortable conception of man's physical importance.

At the turn of the century science delivered another shock. This was even more particularly shattering to his ego. Instead of being created perfect in the image of God, man was shown scientific evidence that seemed to prove he had evolved slowly from a primeval creature. And because by this time there existed more literacy and more literature, a much greater proportion of society learned these distasteful facts more quickly.

With his ego wounded, man discovered that science was rearranging his life in a manner that his father and grandfather would have considered inconceivable.

CHANGES IN WAYS OF LIVING

We cannot possibly cover all the changes applied science has wrought in the old established ways of living. But touching only the obvious high points will amply illustrate the incredible bombardment that science-put-to-service is making on the target of man's consciousness.

The application of science to transportation has given man the greatest mobility he has ever experienced. With the airplane and a highly developed railroad network, superb highways, and a record production of automobiles, our footloose people are on the move with more mobility than man has enjoyed at any time in history. Cross-country and transocean flights have annihilated conceptions of "far-away places" and "foreign" lands.

Science applied to mass production in areas of high population density has shifted man with astonishing rapidity from a rural to an urban society. Families, traditionally farmers, have moved into cities.

In his passive entertainment, man has literally swooped from the parlor phonograph, "flickering" melodrama, and Keystone Cop comedies to far more intense, emotion-stirring "talkies," technicolor, and 3-D. His home was invaded by distracting radio, by still more distracting television. Technology in communications can make his voice travel in minutes to any home in the country; his messages by wire or Teletype can arrive within an hour.

In his offices, he sees billing machines making out bills and automatically posting accounts receivable in the morning, signing out pay checks in the afternoon. In the factory, he may watch with vague uneasiness a machine that converts flour, sugar, shortening, and spices into packaged cookies, or a machine tool that duplicates a machined metal part by direction of a coded tape.

In his newspapers and on his newscasts, he is confounded by reports of weapons that can destroy a coral island and blow a mile-wide hole in the ocean floor.

I have the uncomfortable impression that the application of science has served man rather like a rude but kindly, boisterous governess might handle a sensitive little boy. Such a governess might shatter his eager dream of being a king by abruptly shouting at him that he is unspeakably dirty, needs a bath, needs medicine, and must come inside at once. Then, after snatching the little fellow away from the enjoyable security of his mud castles, she puts him through a bathing, a drubbing, then with his ego shattered, his mind in a whirl, she sits him down, scrubbed, well-fed, and overdressed in clean clothes, to listen while she reads him stories that scare him to death.

Considering that the human species has inhabited the planet for a goodly number of thousands of years—perhaps we should say that man is doing remarkably well to absorb without complete disintegration the changes of the last 40 years—compressed, please note, into the life span of a single generation. He has had to adjust from an agrarian economy to a mass production economy. He has had to shift his thinking from rugged individualism, however co-operative, to group thinking, planning, interdependence. He has had to change his place of abode and manner of living in consonance with shifting industrial demand, mechanized farming. Military service and industrial needs have uprooted millions of individuals and families and scattered them to all parts of the world.

PSYCHOLOGICAL AND EMOTIONAL EFFECTS

Perhaps we tend to minimize the effects of these changes as they affect man's consciousness because, overtly, man appears to have an infinite capacity to take things for

granted. Men of 60 were conditioned in their youth to see vehicles pulled by horses; men of 40 were entertained immensely by 2-reelers with patched-in titles. Both age groups have completely lost any sense of wonder at diesel engines, conventional or jet aircraft, television, or 3-dimensional movies. On the surface, there would appear to be no stress in adjusting to a manner of living that could scarcely have been predicted 25 years ago.

But are there any other indications beyond observation that man's adjustment to the modern world may be exacting a price?

Today, it is estimated that 50 per cent of the hospital beds are occupied by patients with mental disorders. The peoples of the western world have responded to the changes of the last 25 years by developing a shocking increase in psychosomatic disorders. It has been pointed out that these psychosomatic disorders have reached epidemic proportions, and suggested that much of this is traceable to the impact of advancing technology which, as we have mentioned, rapidly changes patterns of family and community living, shuts city dwellers away from contact with nature, deprives the individual of opportunities for spontaneously creative activity, gears human beings to the clockwork rhythm of machines, makes individuals think of their fellowman in mechanistic terms of functions and statistics which are basically out of harmony with human personality. Apparently, a scientific age cannot, with impunity, take a man from plowing leisurely in a muddy field, transpose him to a 16-family efficiency apartment, surround him with brick, steel, and concrete, and whisk him to a mechanical job at production line tempo—without exacting a price.

DILEMMA OF OUR ERA

Is man psychologically or emotionally equipped to stand the impact of the vast changes he is being asked to assimilate so rapidly? Can he readily expand his frame of reference to include the still greater changes just over the threshold of our technological advances in nuclear science, electrochemistry, and biophysics?

This I believe is the classic dilemma of our era.

Has mankind advanced sufficiently in his moral habits to be trusted with the concepts, the extension of the senses, the machinery that science is putting at his disposal? Have ethical systems been enlarged, refined, modernized, if you will, to accommodate the complex, new relationships among individuals, groups, and nations made possible by developments in science? Has man's spirituality deepened, taken strong enough roots in his being, built a firm enough foundation so that his multitude of gadgets and material things will not crowd the more human aspirations out of his consciousness?

These are perplexing questions.

The discordances between what science has shown us how to make and how we employ these technologies has some distressing results. Man's morals and ethical systems have not kept pace with his proficiency in the development and application of the sciences. Because of this, there is a growing tendency of uneasy people to blame science itself for the disturbances of their peace of mind.

Blaming science for its gifts is as pointless as dropping the logic of debate to indulge in personalities. There is neither good nor evil inherent in scientific concepts. What good or evil results stems entirely from man's employment of science, his ability to adjust philosophically as well as physically and psychologically.

INTEGRATION OF SCIENCE WITH HUMANITARIAN GOALS

Progress in the sciences must be matched by progress in the applied humanities, if mankind is to realize true and balanced progress. Science, alone, is too narrow a discipline. As a first step, a study should be made directed toward a measured assessment and correlation of the sciences, toward an integration of scientific education with the humanities.

The time for intuitive beliefs and pragmatic concepts is past. Within our own society, our intuitive feeling that "progress in science" must of necessity be synonymous with mankind's progress toward general well-being should be subjected to critical review.

The social, political, and international issues which preoccupy governments today are largely conditioned by scientific considerations, involving realms of information and ideas largely unfamiliar to the average citizen.

Some people have said that engineers and scientists should be called upon to manage the world, feeling that the scientific method, the pure logical reasoning based on facts would do a better job than politicians are capable of doing.

I cannot totally agree with this. Men trained in the disciplines of science should not be ruled out as potential political administrators, but I do not believe that science training necessarily puts them in a favored, qualified position for such responsibility.

Expanding science to undertake social management and government is not the answer. What is needed in our statesmen, our industrialists, and among all people is an integration of scientific achievements with humanitarian goals.

It would be well for scientists at this critical period of history, to avoid the same distortion of viewpoint which persuaded the 19th century humanists to neglect science. Modern-day scientists should not fail to see that science has a vital relation to humanism—those habits of thinking and modes of action centering upon human interests and ideals.

EDUCATION AS AN ANSWER

The exercise of men's minds should not be restricted merely to the discovery and application of laws which exist independently in a rational, mathematical, impersonal universe, but the translation and application that will give them the most benevolent significance for human beings. Hence the need for integration.

Science grows out of our intense curiosity; uncovering its laws and applying them is a triumph of discernment, logic, accurate measurement, and artful application. But this exercise of the mind coping with the riddle of physical existence is not enough to guarantee the true progress of man. Science is only one part of the whole and we are far from having complete knowledge. Even in the sciences we know so little about so much that we are confused. But

in approaching the concept of integration, let us not shun knowledge, for an increase in understanding in the sciences can in no way change the truth—only the uses of truths.

Perhaps the answer lies in education.

The need for a broader, more positive approach to education is imperative if we are to meet the challenges and the anxieties of the future. Significant changes are needed in our concept of education if we are to condition the coming generations to develop social relationships which will not distort and pervert the application of science. It is interesting and heartening to note that in April of this year, the Carnegie Foundation announced four new grants to foster the study of the effect of the great changes brought about by science and technology on man.

It was not until the rise of modern science in the late 18th and 19th centuries that the dogma of scientific progress was thought to be synonymous with human progress; and became an unquestioned article of popular belief. It was only after the successive explosions of the atomic bomb, the "nuclear device," and the hydrogen bomb that serious public doubts arose over the validity of this belief.

In his speech to the United Nations on the control of atomic energy, Bernard Baruch said:

"We are here to make a choice between the quick and the dead—let us not deceive ourselves: we must elect world peace or world destruction—the terror created by weapons has never stopped man from employing them. For each new weapon a defense has been produced, in time. But now, we face a condition in which adequate defense does not exist."

In the face of this, the representatives of two civilized national governments can find no grounds for co-operation.

No further fact is needed to prove that for mankind's true progress, science alone is not enough.

The American Engineering Council: An Experiment in Unity

A. F. BOCHENEK

The most ambitious attempt at engineering unity thus far has been the American Engineering Council which functioned from 1920 to December 1940. This discussion of its structure and problems* should be of particular interest in view of the current increased demand for a unified engineering profession.

IN JUNE 1920, at a meeting in Washington, D. C., attended by delegates from 71 national, regional, state, and local engineering societies and clubs, the American engineering profession launched its most ambitious effort to achieve unity.

In an atmosphere of enthusiasm and unanimity the delegates organized The American Engineering Council of the Federated American Engineering Societies "to further the public welfare wherever technical and engineering knowledge and experience" were involved and "to consider and act upon matters of common concern to the engineering and allied technical professions."

During the next 20 years, in an effort to achieve these objectives, the engineering societies invested nearly a million dollars in The American Engineering Council (AEC).

One year after it was organized, the AEC published its monumental report, "Waste in Industry," which had a profound effect on management of industry in the United States and abroad. The report was published in four foreign languages and did much to strengthen the influence abroad of American engineers. This report was followed by others which have left their mark on how Americans live and work.

Throughout its existence, the AEC adhered scrupulously to the philosophy of service laid down by Herbert Hoover, its first president, when he said that AEC was not a pressure group, had no economic interest for its members; but was "an association for public service to give voice to the thought of engineers" in national problems of an engineering nature.

Under his leadership the AEC soon established itself in the official mind of Washington as a constructive agency working without ulterior motive for the public good. Officers of the government departments and legislators of both political parties found that they could depend on AEC for objective judgments on engineering problems pertaining to legislation. AEC committees studied pending legislation and reported progress to member societies through a monthly bulletin and news releases in engineering journals.

By its research activities, its legislative services, and its interest in the betterment of the engineering profession, the AEC demonstrated that it was an effective instrument of

* Copies of the complete text of this article, which was issued in pamphlet form by the ASME, may be obtained free of charge from the AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

A. F. Bochenek prepared this article in 1951 when he was technical editor of *Mechanical Engineering*, New York, N. Y.

professional unity until 1934 when a drastic reduction in contributions from member societies and clubs caused the AEC to reduce and reorganize its program and staff.

Unable to provide the services expected of it by governmental legislators, AEC headquarters in Washington became more and more "an embassy of engineering" and functioned as an information center and news-gathering agency. But even the cost of this limited service became a burden to the national member societies.

Finally in 1940 in an atmosphere of general apathy, the American Society of Civil Engineers (ASCE), The American Society of Mechanical Engineers (ASME), and AIEE, the "big three" who were carrying more than 90 per cent of the financial burden of operating the AEC, decided to withdraw their membership. The AEC closed its Washington office and suspended operation.

Among those who were active in AEC affairs, few can agree why after the signal achievements of the 1920's, the AEC failed to sustain the high level of interest in engineering unity which had been so strong during the postwar years of World War I.

PREDECESSOR ORGANIZATION

The American Engineering Council was not the first attempt at unity of the engineering profession. In 1917 with the nation at war, the Founder Societies [ASCE, American Institute of Mining and Metallurgical Engineers (AIME), ASME, and AIEE] formed a joint agency to work with the government on engineering problems involved in developing the automobile, tank, and airplane into major weapons of national defense. This body was known as the Engineering Council of the National Technical Societies of America.

During the next 3 years the joint agency performed six tasks which convinced the government that the engineering profession was able and willing to accept high responsibility. The work of the agency also aroused among engineers an interest in some kind of a unity organization which would be truly representative of engineering societies on the national and local levels. The first council accomplished six major tasks:

1. Organized 24 committees composed of 150 prominent engineers to work with departments of the government to develop and perfect weapons and appliances needed to prosecute a mechanical war.
2. Served as a bureau of technical manpower through which names of 4,000 engineers were passed on to departments of the government who needed engineers for war duties of an engineering nature.
3. Worked with Army and Navy in examining 135,000 suggestions and inventions for war devices.
4. Worked with the Fuel Administration to establish a program for conserving coal.
5. Established the Engineering Societies Employment Services which registered more than 5,500 engineers, mostly veterans returning to civilian life, thousands of whom were placed without charge.
6. Established a Washington office through which individual engineers, companies, and societies, were informed on activities of Congress and rendered useful services of an engineering nature to the government.

When the war ended an effort was made by the predecessor council to expand its membership and to undertake peacetime services of a public nature. In line with this policy the Council sponsored in April 1919 a conference of engineering organizations to discuss the establishment of a department of public works on a cabinet level. The conference brought together for the first time representatives of 74 national, regional, state, and local engineering groups and uncovered a widespread desire among engineers for a new unity group in the organization of which all groups could share.

These events created a favorable climate for launching the American Engineering Council. By agreement, the joint agency ceased to function on January 1, 1921, and turned over to the AEC, its records, funds, and its Washington office and staff.

Although the AEC and the predecessor organization had similar and therefore confusing names, they were inherently different organizations, created by different individuals and for different purposes. The predecessor council was an emergency agency sponsored by the Founder Societies to assist a government coping for the first time with a mechanized war. The AEC was a peacetime agency sponsored by a large number of national, local, state, and regional engineering societies and clubs organized for the betterment of the profession by opening up opportunities for engineering services in and out of the government.

FEDERATION OF SOCIETIES

The AEC was established after considerable debate as a federation of societies and not as an organization of individuals. It functioned through a council and an executive committee. The council, or assembly as it was later called, was composed of representatives of member societies on the basis of one representative for each 1,000 members. The council met annually in January. The executive committee, later called the administrative board, was composed of 30 members, six of whom were AEC officers. The remaining 24 were selected, some by national societies and some by regional, state, and local organizations, according to districts, from members of the council. Representation of national societies on the executive committee was determined by the ratio of the total membership in national societies to the total membership in local societies and clubs.

Financial support for the AEC came from assessments of member organizations. The original assessment was $1.50 per member for national societies and $1 for regional, state, and local societies. This was later changed to a uniform assessment of not more than $1 per member, the exact amount to be determined annually. In 1935, to encourage membership among regional, state, and local organizations, dues were reduced to a maximum of $25 to all but national organizations.

Officers of the Council were: a president, elected every 2 years; four vice-presidents, two of whom were elected each year; and a treasurer, who held office for 1 year.

All decisions affecting policy or action of the AEC re-

quired a two-thirds affirmative vote of representatives present at any meeting or vote by letter-ballot. No action was valid which was opposed by: (1) one half of the total number of representatives of any one of the national member organizations having six or more representatives on the assembly; (2) one half of the aggregate of representatives of other national member organizations; (3) one half of the aggregate of the representatives of the local, state, and regional member organizations.

Of the 71 societies and clubs who were represented at the AEC organizing meeting in 1920, 20 accepted membership in the unity organization during the first year. Eventually 44 other societies joined, but the Council was never sure from year to year which of its members would decide to withhold its assessment and drop its membership. Membership of national societies varied from 4 to 7; that of regional and state societies from 4 to 18; and that of local societies from 7 to 27. Over-all membership was lowest in 1932 when many societies found they could not pay AEC dues, and was highest, paradoxically, in 1940, when the Council ceased to function.

RESEARCH ACTIVITIES

One of the first actions of the AEC in 1920 was to initiate an intensive study into the elimination of waste in American industry. The report was published in 1921 under the title "Waste in Industry." It was translated into four foreign languages, and had a profound influence in every industrial country in the world. In the United States alone it was credited with saving industry about $600 million annually.

The Council's report, "The Twelve-Hour Shift in American Industry," published in 1923, compared the advantages of two 12-hour shifts against three 8-hour shifts in the continuous industries. The findings were credited with the elimination of the 12-hour shift in the steel industry and eventually in other industries.

At the request of the U. S. Coal Commission, AEC studied stabilization of the coal industry. In 1924 its report, "Industrial Coal–Purchase, Delivery and Shortage," recommended annual contracts specifying equal monthly delivery for stabilized production.

In co-operation with the Department of Commerce, the Council made a survey of commercial aviation in 1925. This led to the establishment of a Bureau of Aviation in the Department of Commerce and provided the new agency with a source of authoritative information on many phases of commercial aviation.

In 1928 the Council's report, "Safety and Production," showed that there was a relationship between accident rate and production rates. It stressed the advantages of safety work as measured in production per man-hour and therefore the wisdom of spending money to eliminate accident hazards.

In 1929 the Council issued a standard code on "Street Traffic Signs, Signals, and Markings" which was adopted by the National Conference on Street and Highway Safety, and widely used by many municipalities.

In 1932 the Council completed for the Department of Commerce a report of "Airport Drainage and Surfacing," which assembled useful information for engineers responsible for construction of airports under various conditions of terrain.

The Council was active in the President's Conference on Unemployment and contributed several studies on economic changes in the United States and the balancing of economic forces. These reports were published widely in the technical press and were influential in broadening the interest of engineers to social and economic matters beyond the traditional purview of the profession.

The AEC expended more than $100,000 on its research activities, most of which came from gifts.

SERVICE TO LEGISLATORS

In its work the AEC was scrupulously faithful to the philosophy of public service enunciated by its first president, Herbert Hoover. In his address at the first meeting of the AEC, Mr. Hoover said that the only interest of the Federated American Engineering Societies was to offer help to individuals in constructive solution of problems of all economic groups such as business, labor, and farmers' associations. The AEC, he said, stood somewhat apart from "these great economic groups in that it has no special economic interest for its members."

The AEC fulfilled this objective of public service by making available to officers of the Government, legislators, and other civic and economic groups, the training, experience, and point of view of the nation's best qualified engineers. This service was performed quickly and confidentially and in a manner which established the AEC as a unique public service organization.

To keep itself informed on Congressional bills touching on matters involving engineering judgment, the AEC often had more than 50 committees looking into various phases of pending legislation. The range of its interests is illustrated by the following:

Forestry: Because of its support of all constructive legislation in conservation of forests, the Council was consulted by many lay groups interested in forestry.

Topographic Surveys and Maps: AEC called attention to need for appropriations for a completing topographic survey within 20 years.

National Hydraulic Laboratory: AEC was instrumental in securing the establishment of a National Hydraulic Laboratory where river flow, flood control, and other important hydraulic problems could be studied scientifically.

Patents: AEC assumed leadership in co-operation with other groups to effect reform in the Patent Office so that the Patent system would be of greater service to the American people.

U.S. Public Health Service: AEC aided in reorganization of U.S. Public Health Service; establishment of the National Institute of Public Health; and enhancement of the status of sanitary engineers in the Service.

Federal Public Works: Consistently worked for a Department of Public Works to co-ordinate all engineering, construction, and architectural functions of the government.

Government Personnel: AEC supported all legislation designed to improve character, advancement, and general improvement of the status of the technical and scientific personnel in the Federal Government.

SERVICES TO THE ENGINEERING PROFESSION

In fulfilling its objectives, the AEC continuously sought to create opportunities for service for engineers in and out of Government. In its work with government officials AEC sought appointment of engineers on boards and commissions created to undertake tasks involving engineering judgment. It worked to enhance the status of engineers in government service.

Every attempt, however, to use the AEC as an instrument for increasing engineering salaries was discouraged because such action was interpreted by delegates as incompatible with AEC function of disinterested public service. AEC limited its interest in economic status to the fact-finding level. It encouraged its member organizations to collect facts on engineering salaries and in 1935 was instrumental in having the Bureau of Labor Statistics conduct a comprehensive survey of engineering salaries which provided for the first time reliable information on this subject on a profession-wide basis.

The AEC perhaps served the profession as a fountainhead of information about engineers conveniently accessible to government departments and commercial interests seeking services of competent engineers. The Council maintained a roster of more than 115,000 names and records of engineers. In 1930 the AEC was instrumental in making the third edition of "Who's Who in Engineering" a semiofficial record of the profession by writing specifications for listings and by making its roster available to the publishers.

Particularly useful to the profession was the special knowledge accumulated by the AEC in and around Washington, D. C., which was made available to engineers through a monthly bulletin and through news releases published in society journals.

The conferences of secretaries of engineering societies sponsored by the AEC did much to promote understanding on common administrative problems among engineering organizations working on the local, state, and national levels.

While the AEC did serve individual engineers who asked for aid and information, most engineers regarded it as a remote organization working in an indirect and intangible way for the betterment of their profession.

THE PROBLEM OF FINANCE

Opportunities for public service open to the American Engineering Council always exceeded the financial resources of the organization. Projects undertaken were of necessity limited to anticipated income.

The AEC was hardly a year old when the business recession of the early 20's caused some organizations to talk about leaving the Council. A great deal of effort was expended by officers to urge member organizations from taking such action.

Planning the budget was always a trying experience because contributions from member organizations were uncertain at best. Except for a few national organizations, there was a tendency for member groups to withhold payment until well into the administrative year. With the approach of the depression of the 1930's, many local societies and clubs stopped contributing to the financial support of the Council.

In the main, financial support came from three national engineering societies: ASME, AIEE, and then after 1929, the ASCE.

Contributions from these three organizations accounted for as much as 95 per cent of AEC income and never less than 75 per cent. AEC income from member organizations reached a peak in 1931 when assessments reached the $58,000 mark. Three years later the Council was confronted with a 2/3 cut in operating funds. Assessments in 1934 reached a low of $20,000.

LEADERSHIP

The following engineers served as AEC presidents: Herbert Hoover, past president AIME; Mortimer E. Cooley, past president ASME; James Hartness, past president ASME; Dexter S. Kimball, past president ASME; Arthur W. Berresford, past president AIEE; C. E. Grunsky, past president ASCE; William S. Lee, past president AIEE; John F. Coleman, past president ASCE; A. A. Potter, past president ASME; William McClellan, past president AIEE; Alonzo J. Hammond, past president American Society for Engineering Education.

SUSPENSION OF OPERATIONS

Growing dissatisfaction with the organizational structure and program of the American Engineering Council culminated in 1939 in the appointment of a joint committee composed of representatives of the ASCE, ASME, AIEE, and the AEC to study the basic aims and objectives of the Council and to suggest ways and means through which these could best be achieved.

The report of the joint committee released on July 22, 1940, stressed the need for "a strong national organization located in Washington to represent engineers." It recommended appointment of a co-ordinating committee composed of secretaries of Founder Societies to serve a liaison function between the executive secretary of AEC and the governing boards of the Founder Societies. Finally, the joint committee set a minimum budget of $25,000 for effective operation of the AEC.

On July 23, 1940, the ASCE announced its intention to withdraw from the AEC at the end of the year. The governing board of the AIEE took a similar action on September 24, 1940.

Convinced that the decisions of the ASCE and AIEE were final, the Executive Committee of the Council of the ASME on November 8, 1940, authorized its president to urge AEC to terminate activities in a business-like manner by December 31, 1940.

AEC, as a functioning body, ceased on December 31, 1940. Its properties were sold, except for its records and files which are currently stored in the Engineering Societies Building, New York, N. Y. An incomplete set of AEC files is also in the Library of Congress.

Induction Motor Speed-Torque-Current Curves

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A METHOD OF ANALYZING the induction motor speed-torque-current curves as a function of voltage is presented in this article. It is shown that the current will vary differently from the first power of the voltage; and the torque differently from the square of the voltage. The results obtained from any individual test are applicable to a specific design and cannot be considered as the correct solution for any general class of design. This method is applicable to synchronous as well as induction motors.

The AIEE Test Code for Polyphase Induction Machines Number *500* states that the speed-current and speed-torque curves may be obtained at or near rated voltage. If obtained from a lower than rated voltage, the current is assumed to vary as the first power of the voltage and the torque as the square of the voltage. These assumptions are in accordance with accepted theory which neglects saturation effects, eddy current effects in deep rotor cage bars, and the numerous double-cage constructions.

During the past 5 to 10 years, certain applications have required more accurate speed-current curves and particularly speed-torque curves during acceleration. In order to obtain the required torque for acceleration in the critical speed range as well as to obtain maximum efficiency, minimum locked-rotor current for a given breakdown torque, and maximum power factor, the effect of saturation from zero to full speed must be determined. To determine this effect, extensive tests were made on a 900-hp 3-phase 60-cycle 4-pole 4,160-volt squirrel-cage induction motor utilizing a single-cage deep-bar rotor. The motor was loaded by a calibrated dynamometer rated 2,000 hp at 3,000 rpm. Power supply was obtained from five transformer taps designated as 80, 65, 55, 45, and 35 per cent of rated voltage.

The locked-rotor test was taken from 0- to 86.5-per-cent voltage and the curve extended to rated voltage. A point-by-point analysis gave an average current variation as the 1.09 power of the voltage.

The speed-current data were analyzed by ratioing the current to rated voltage as the first power of the voltage. Curves were plotted, Fig. 1, to show the difference in current as the voltage is increased. It was concluded that the current varied as the 1.09 power of the voltage from 0 to 85 per cent of synchronous speed; whereas at breakdown speed the current varied as the 1.03 power of the voltage.

Fig. 2 shows the speed-torque curves ratioed up as the square of the voltage for each test voltage. The change in torque appears as the 2.14 power of the voltage for breakdown speed and as the 2.38 power of the voltage for speeds from 0 to 85 per cent.

Tests taken in this manner on other induction motors have shown the same type of results. These results clearly indicate that the current and torque will increase at a faster rate than is assumed in the AIEE test code. If the test code is followed when critical operating conditions exist, a higher current must be accepted for a given breakdown torque. If a critical torque condition exists during acceleration, the torque must be increased at expense of higher rotor resistance and loss. Curves taken at two (or preferably three) reduced voltages will indicate the rate of change in current and torque as a function of voltage. The data must be taken at voltages as high as possible.

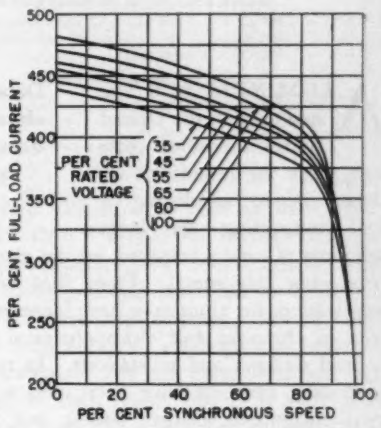

Fig. 1. Speed-current curves, referred to rated voltage as the first power of the voltage

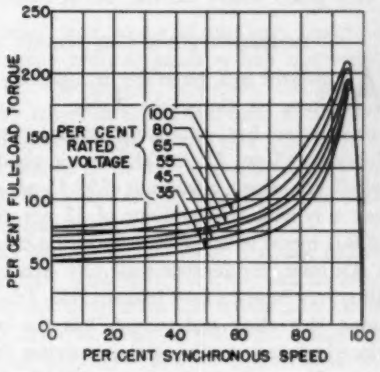

Fig. 2. Speed-torque curves, referred to rated voltage as the second power of the voltage

It is recommended that the test method outlined in this article be recognized by industry and the AIEE test code as a method of obtaining the true speed-torque-current curves for those motors which must be tested at reduced voltage, and where performance characteristics are critical enough to warrant an exact determination.

Digest of paper 54-95, "A Method of Determining Induction Motor Speed-Torque-Current Curves From Reduced Voltage Tests," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Published in AIEE *Power Apparatus and Systems*, June 1954, pp. 670–5.

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Mechanical Properties of Aluminum Electric Bus

G. W. STICKLEY C. O. SMITH

Data concerning the mechanical properties of aluminum bus are supplied together with a detailed discussion of a number of recent tests and a brief summary of previous tests.

ALUMINUM BUS was first used in the United States almost 60 years ago, when the aluminum industry began employing it for transmitting the large amounts of power required by the electrolytic process for producing this metal. From that beginning, electrical applications for aluminum have increased and now include uses in chemical and electrochemical plants, steel mills, central stations, and substations. In recent years, rapidly increasing amounts have been used in buildings, switchgear equipment, control panels, and, in fact, in almost every place where electric bus is employed.

COMPOSITIONS AND FORMS AVAILABLE

ALUMINUM BUS generally is available in three compositions, as shown in Table I. Bus in the form of rectangular bar, channels, angles, and solid rounds is fabricated from *EC* metal (electric conductor composition) which contains a minimum of 99.45-per-cent aluminum and has a typical conductivity of 62 per cent. The strength of this metal is dependent upon the cold work it receives.

Tubular conductors generally are of a relatively new alloy in a heat-treated temper, *63S-T6*. For most applications, this alloy and temper has the best combination of electrical and mechanical properties for outdoor tubular bus. Its conductivity is good, although not as high as that of *EC*. When closer tolerances and higher strength are needed, another temper of this alloy, *63S-T83*, is recommended. For those applications where strength is of still greater importance and conductivity requirements are lower, *61S-T6* is used. Where greater conductivity is needed but lower strength is accepted, *EC* is available.

TYPICAL PROPERTIES

THE typical ultimate tensile strength, tensile yield strength, and elongation of each of the different alloys and tempers, together with certain physical properties, are included in Tables I and II. The modulus of elasticity of each of the three compositions is 10,000,000 pounds per square inch (psi). Other mechanical properties also are of interest in particular applications. Compressive characteristics are of importance, for example, when the mechanical effects of short circuits must be considered. Bend ductility is important in designs requiring bus to be bent severely during installation.

MATERIALS TESTED

TO obtain data concerning these additional properties samples from commercial lots of bus were used. There were 62 samples of rectangular *EC* bar in the *-H12*, *-H13*, and *-H17* tempers, consisting of 31 sizes ranging from 1/8 by 1/2 inch to 1/2 by 6 inches, all produced either by rolling or by rolling followed by drawing. There were 16 samples of *63S* tubular conductors in the *-T6* and *-T83* tempers ranging in size from 1/2-inch outside diameter (OD) by 0.050-inch wall to $8^5/_8$-inch OD by 0.322-inch wall [8-inch standard pipe, American Standards Association (ASA) Schedule 40].

Butt-welded specimens of most of the sizes of tubular conductors were provided. The welds were made with *43S* (aluminum-5-per-cent silicon) wire, by either the argon-shielded tungsten-arc process or gas welding.

METHODS OF TEST

TENSILE and compressive tests of each sample were made in accordance with American Society for Testing Materials methods.[1,2] Only tensile tests were made on the welded tubular conductors.

Condensed text of paper 54-137, "Mechanical Properties of Aluminum Electric Bus," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Published in AIEE *Power Apparatus and Systems*, April 1954, pp. 100–06.

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Table I. Typical Compositions and Physical Properties of Aluminum Bus

Alloy and Temper	Composition, % Cu	Si	Mg	Cr	Weight Lb/Cu Inch	Specific Gravity	Coefficient of Linear Expansion, Per ° C	Thermal Cond. at 20 C Watts/Sq Inch /In./Sec/°C	Electrical Properties at 20 C: Conductivity, % IACS	Resistance, Microhms /Sq In./Ft	Temperature Coefficient of Resistance, Per °C
*EC**	99.45% min. Al				0.098	2.70	0.000023	6.0	62	13.14	0.00409
63S-T6	0.4	0.7	..					5.1	53	15.37	0.00350
63S-T83	0.4	0.7	..					5.4	56	14.55	0.00370
61S-T6	0.25	0.6	1.0	0.25				3.9	40	20.36	0.00265

* All tempers.

From the tensile and compressive tests of several representative samples of each composition and temper, typical stress–strain curves were prepared. In one test of *EC-H13* bar a special specimen was used on which elongation was measured in small gauge lengths to show the distribution of elongation.

Two types of bend tests, flatwise and edgewise, were made on the samples of rectangular *EC* bar to determine the minimum radius of bending that could be used.

The flatwise bend tests were made with the thickness radial to the bend. Bars 1/4 inch or less in thickness were bent over steel dies held in a machinist's vise, using a rawhide mallet to force each bar around the die. Thicker bars were tested by loading as simple beams in a universal testing machine. In each test a full-size specimen of each bar first was bent 90° around a radius equal to the thickness, as required by specifications.[3] The angle then was increased to 180°, and finally the bar was flattened on itself (zero bend radius).

In the edgewise bend tests, the bar was bent 90°, with the bar remaining in the plane of the width. The tests were performed in the bend-testing machine shown in Fig. 1. The machine, which was developed at the Aluminum Research Laboratories as previously described,[4] uses a restraining device to keep the bar flat and to minimize wrinkling on the inside edge of the bend. Bars as thick as 1/2 inch can be bent, and available radii are 1/2, 3/4, 1, 2, 3, and 4 inches. The bars were tested full-size except when limitations of the testing machine prevented testing some of the largest sizes without using specimens of reduced width. Tests of specimens having reduced widths are not representative of the ability of the bar to be bent full-size,[4] but can be considered representative of bar of the reduced width having the same tensile properties.

A specimen on which a grid had been applied before being bent is shown in Fig. 2.

When a bar is bent edgewise, the inner edge becomes thicker and the outer edge becomes thinner. This thinning generally is uniform along the edge, but in some cases is localized slightly, and in extreme cases this localized thinning proceeds until rupture occurs. Slight localized thinning, which ordinarily would not be noticeable, was considered acceptable; therefore, the test of any specimen was considered satisfactory if the minimum thickness was at least 90 per cent of the maximum thickness along the middle 60° of the outer edge of the bend.

RESULTS OF TESTS

All of the conductors tested met the tensile requirements of available specifications.[3,5,6] Typical tensile and compressive stress–strain curves for the different tempers of *EC*, *63S*, and *61S* bus are shown in Figs. 3 and 4.

PROPERTIES OF RECTANGULAR BARS

The average tensile properties of the *EC* bars agreed closely with the nominal values for the respective tempers shown in Table II. The compressive yield strength always was less than the tensile yield strength, averaging from about 10 per cent lower for the *EC-H12* to 15 per cent lower for the *EC-H17*.

Table II. Typical Tensile Properties of Aluminum Bus

Alloy and Temper	Commercial Products	Ultimate Tensile Strength, PSI	Tensile Yield Strength, (Offset = 0.2%), PSI	Elongation in 2 Inches, Per Cent
Rectangular Bars, Channels, Angles, Solid Rounds				
EC-H12	Rect. bar, channel, angle	15,000	12,000	35
EC-H13	Rect. bar, solid round	17,000	16,000	20
EC-H17	Rect. bar	20,000	19,000	14
Tubular Conductors				
63S-T6	Pipe, tube	35,000	31,000	12
63S-T83	Pipe, tube	38,000	36,000	10
61S-T6	Pipe	45,000	40,000	12

Each of the *EC-H12* and *EC-H13* bars met the specification[3] requirement that it should be capable of being bent flatwise through an angle of 90° over a radius equal to the thickness without cracking and with no apparent evidence of slivers or other imperfections. The *EC-H17* bars also withstood such bending, although not required to do so by specifications.[3] All the bars withstood this flatwise bend easily, for each finally was bent 180° over zero radius without failure, although a few showed slight surface cracking.

In the edgewise bend tests, many of the bars could be bent satisfactorily around radii as small as half the width (0.5W). It should be remembered, of course, that success in making satisfactory edgewise bends will depend to some extent upon the equipment and procedures used. It is possible that bars capable of being bent satisfactorily in the machine used in this study would fracture when bent with less suitable equipment.

Results of the edgewise bend tests show that the radius (in terms of width of bar) around which a bar can be bent satisfactorily depends not only upon the tensile properties of the bar but also upon its ratio of width to thickness. This is illustrated in Fig. 5. Samples represented by points above the arbitrary broken line could not be bent satisfactorily around a radius of 1W, which is a radius commonly used. Some lots of bar, as produced commercially, however, will have strengths higher than the typical value. In such cases, bars of *EC-H12* and *EC-H13* may be expected to withstand bending edgewise around a radius of 1W, provided the respective ratios of width to

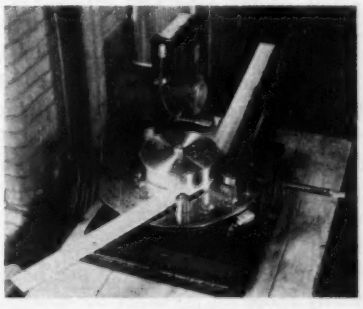

Fig. 1 (left). Bend-testing machine showing edgewise bending of 1/4- by 3-inch bus bar. Fig. 2 (right). EC-H13 aluminum bus bar, 5/16 by 2 inches, bent around a 2-inch radius

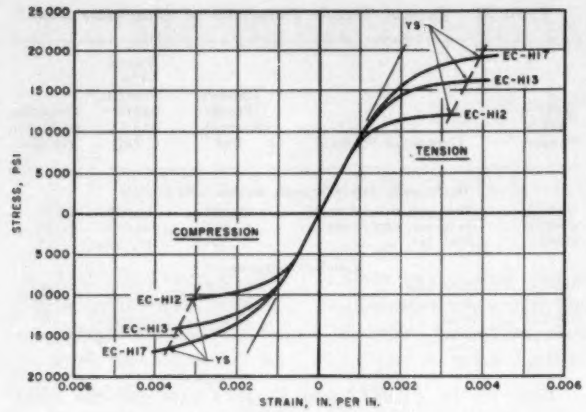

Fig. 3. Typical stress–strain curves for EC aluminum bus

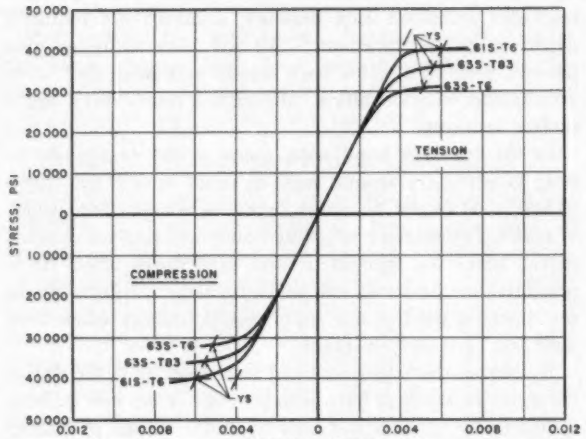

Fig. 4. Typical stress–strain curves for 63S and 61S tubular aluminum bus

thickness do not exceed 12 and 8. Bars of *EC-H17* generally should not be used where edgewise bending is required.

When a bar is bent edgewise, the inner edge becomes thicker and shortens, while the outer edge becomes thinner and lengthens. The average increase in thickness along the inner edge was about 20 per cent and the average decrease along the outer edge was about 16 per cent. The radial width across the bend was about 3 per cent less than the original width. The inner edge was shortened about 30 per cent, the outer edge was lengthened about 35 per cent, and the center line was elongated about 4 per cent. For the different bars tested, the variation in extent of these changes was small, irrespective of the actual tensile properties of the bar.

In this connection, it should be noted that the elongation of 35 per cent along the outer edge of a bar that had been bent edgewise often greatly exceeded the value for elongation in 2 inches as determined in a tensile test. There is no direct relation, of course, between these two values, as will be evident from the results of the elongation survey of a tensile specimen from an *EC-H13* bar, shown in Fig. 6. In a tensile test, the elongation that occurs consists of two parts: (1) the uniform elongation that occurs throughout the test section and (2) the localized elongation in the vicinity of the fracture. The value for elongation, therefore, will vary with the gauge length, ranging, in the example shown in Fig. 6, from 72 per cent in 0.5 inch to 14 per cent in 4 inches. The uniform elongation was about 5 per cent, which is considerably less than the 35 per cent obtained in the edgewise bend test.

PROPERTIES OF TUBULAR CONDUCTORS

THE tensile properties of the *63S* tubular conductors were within the ranges obtained commercially. The compressive yield strengths for both the *-T6* and *-T83* tempers were about equal to the respective tensile yield strengths. This same relationship exists for *61S-T6*.

It is sometimes desirable to flatten the ends of tubular conductors so that bolted connections may be made. Tubes of *EC* metal can be flattened cold. The ends of tubes of *63S*, however, must be heated first. Tests showed that this can be done readily by applying a torch for a short time to the two diametrically opposite portions of the tube which will be the edges after flattening. In so doing, care must be taken not to cause melting. With an oxy-acetylene torch, sufficient heating can be obtained in 15 to 30 seconds. The tube then can be flattened either hot or cold without fracturing. Obviously, such heating causes a localized reduction in the strength of the tube but not necessarily enough to anneal the metal fully. Tests of *63S-T6* have shown that heating to 600 F in 4 minutes reduces the tensile strength about 25 per cent and the tensile yield strength about 35 per cent. Tubes subjected to this same heating were flattened easily. Tubes of *61S-T6* also can be flattened, but because of the higher strength of this alloy, longer heating is required.

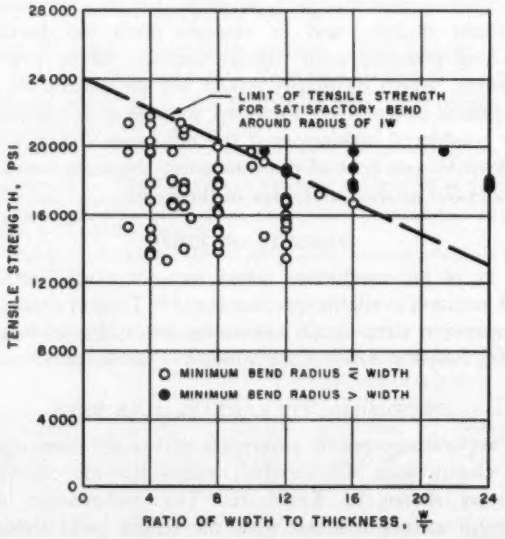

Fig. 5. Tensile strength versus W/t ratio for rectangular EC bar bent edgewise 90° around 1W

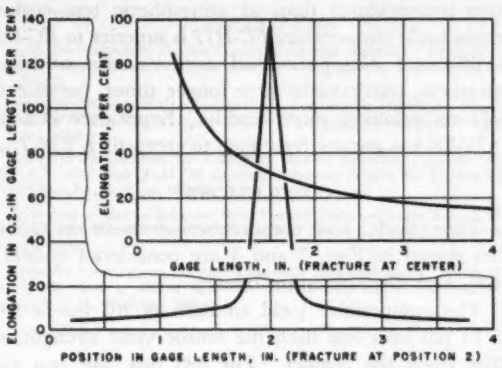
ELONGATION IN 0.2-IN GAGE LENGTH, PER CENT
ELONGATION, PER CENT
GAGE LENGTH, IN. (FRACTURE AT CENTER)
POSITION IN GAGE LENGTH, IN. (FRACTURE AT POSITION 2)

Fig. 6. Elongation survey of EC-H13 bar: 5/16- by 2-inch bar; 1/2-inch-wide tensile specimen

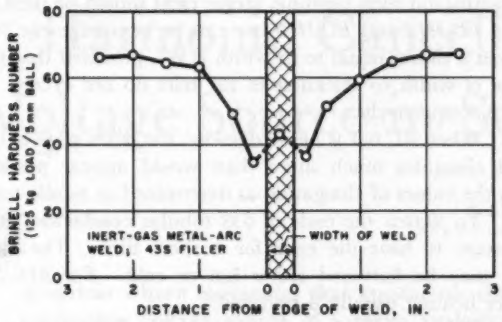
BRINELL HARDNESS NUMBER (125 kg LOAD/5mm BALL)
INERT-GAS METAL-ARC WELD; 43S FILLER
WIDTH OF WELD
DISTANCE FROM EDGE OF WELD, IN.

Fig. 7. Brinell hardness survey on butt-welded 63S-T83 tube, 4-inch by 0.100-inch wall

Tubular conductors often are bent to form turns and offsets. Tests have shown that in commercial practice radii as small as four times the diameter of the tube, or even less if the relation between wall thickness and diameter is favorable, can be used satisfactorily in bending *63S-T6*, *63S-T83*, and *61S-T6* pipe.

STRENGTH AND RESISTANCE OF WELDS

In some construction, bus is joined by welding. The inert-gas metal-arc methods usually are employed although oxy-hydrogen or oxy-acetylene welding also can be used. Tests have demonstrated that *EC* bars when butt-welded with *EC* wire by either of these processes have tensile strengths of at least 10,000 psi. In the tests of *63S-T6* and *63S-T83* tubular conductors butt-welded with *43S* wire (aluminum-5-per-cent silicon), average strengths ranged from about 17,000 to 22,000 psi. The lowest value, 16,900 psi, was 70 per cent higher than the minimum strength of butt welds in *EC* aluminum. In general, the welds were stronger than the adjacent metal, which had been softened by the heat of welding. The metal at this location was not fully annealed, however, for the lowest strength in the tests still is considerably above the typical tensile strength of 13,000 psi for annealed *63S* alloy. Previous work has indicated that the strengths of butt welds in *61S-T6* will be at least 23,000 psi.[7]

The effect of the heat of welding is illustrated in Fig. 7, which shows the results of a Brinell hardness survey adjacent to the weld in a 4-inch OD by 0.100-inch wall *63S-T83* tube. The lowest value of hardness, 34, is considerably higher than the typical value of 25 for annealed *63S*. In this sample, the effect of the heat of welding extended from the weld a distance of 15 to 20 times the wall thickness. For thicker tubes, this effect would not extend as far.

The strengths of welds in *63S* are the same for both the *-T6*, and *-T83*, tempers. Arc welds frequently have slightly higher strengths than oxy-hydrogen welds because of the relatively shorter time of application of heat to make the weld.

The electrical resistance of properly welded joints in aluminum bus, when made with full penetration, is no greater than that of the bus material. For example, in measurements of joints in a *63S-T6* tube and in the *63S-T83* tube used in the hardness survey (Fig. 7), the resistance of a $4^1/_2$-inch length across each joint was not significantly different from that of an equal length of original tube. Similar results have previously been reported for welds in bus of commercially pure aluminum (*2S*).[8]

EFFECTS OF TEMPERATURE ON TENSILE PROPERTIES

In some installations, bus may be subjected to slightly elevated temperatures either temporarily or for prolonged periods of time. Such heating generally has only

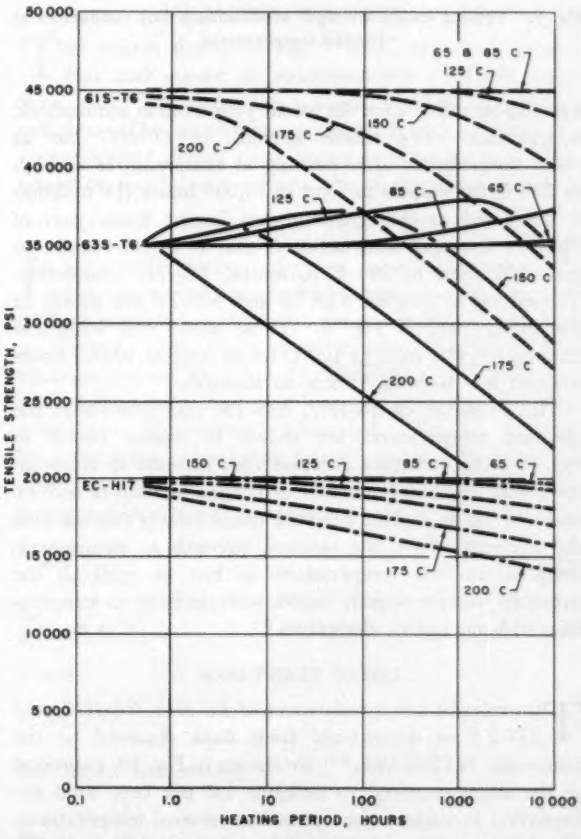

Fig. 8. Typical tensile strength of aluminum bus conductors at room temperature after heating

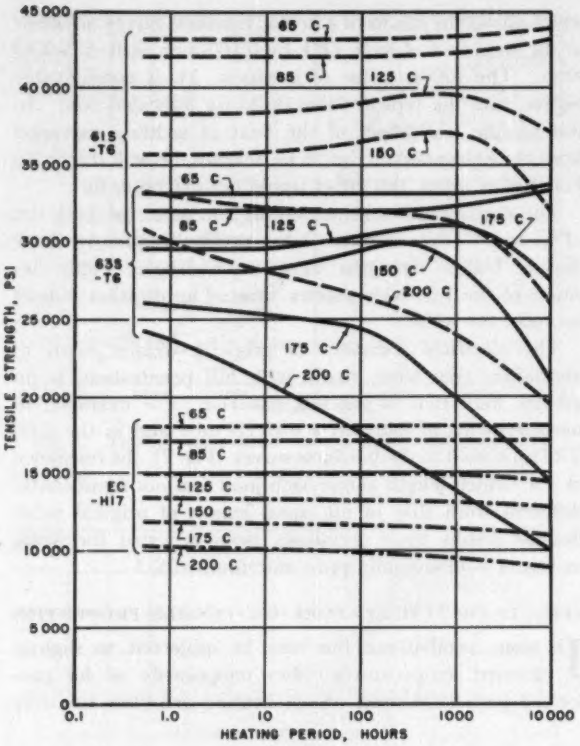

Fig. 9. Typical tensile strength of aluminum bus conductors at elevated temperatures

a negligible effect upon the tensile properties at atmospheric temperature. The tensile strength of *EC-H17* bar at room temperature after heating at temperatures as high as 200 C for periods as long as 10,000 hours (14 months) is decreased to the extent shown in the lower part of Fig. 8. Extrapolation indicates that it would require at least 100 years at 200 C to anneal *EC-H17* completely. The effects of heating *63S-T6* and *61S-T6* are shown in the upper part of Fig. 8. These alloys can withstand temperatures as high as 100 C for as long as 10,000 hours without any harmful effects on strength.

The strengths of *EC-H17*, *63S-T6*, and *61S-T6* at the elevated temperatures are shown in similar curves in Fig. 9. The strengths decrease with increase in temperature, with the exception that prolonged heating of *63S-T6* and *61S-T6* at slightly elevated temperatures can increase the strength above the original strength at atmospheric temperature. At temperatures as low as −80 C, the strengths become slightly higher with decrease in temperature with no loss in elongation.[9]

CREEP RESISTANCE

The relative creep resistances of *EC-H12*, *EC-H17*, and *63S-T6* as determined from data obtained at the University of California,[9,10] are shown in Fig. 10, expressed as the stress required to produce 1.0 per cent total deformation in various time periods at several temperatures. The creep resistance of *63S-T6* is superior to that of *EC-H12* and *EC-H13*, the differences being even larger at elevated temperatures than at atmospheric temperature. At atmospheric temperature *EC-H17* is superior to *EC-H12*. This difference disappears and even reverses at higher temperatures, particularly after longer times, because the *EC-H17* recrystallizes more readily. Experience indicates that *61S-T6* has greater resistance to creep than *63S-T6*.

CONCLUSIONS

1. The tensile and compressive stress–strain characteristics shown in Figs. 3 and 4 are considered typical of *EC*, *63S*, and *61S* aluminum bus.

2. The compressive yield strength of *EC* bus is from 10 to 15 per cent less than the tensile yield strength, depending upon the temper. For *63S* bus, the two yield strengths are about equal, and the same is true for *61S* bus.

3. *EC-H12* and *-H13* bar can be bent flatwise 90° over a radius equal to its thickness (1t). While *EC-H17* usually will withstand such bending, larger radii should be used.

4. *EC-H12* and *EC-H13* bar can be bent edgewise 90° around a radius equal to its width (1W), provided that the ratios of width to thickness of the bars do not exceed 12 and 8, respectively.

5. When *EC* bar is bent edgewise, the outer edge of the bend elongates much more than would appear possible from the values of elongation as determined in tensile tests.

6. To flatten the ends of *63S* tubular conductors, it is necessary to heat the ends for a short time. The ends then may be flattened either hot or cold. For *61S-T6*, longer heating usually is required.

7. Tubular conductors may be bent around radii as small as four times their diameters (4D).

8. Welds in *EC* bus develop tensile strengths of at least 10,000 psi; in *63S* bus, 17,000 psi; and in *61S* bus, 23,000 psi.

9. The electrical resistance of welded joints in aluminum bus is no greater than that of the bus material.

10. The operation of aluminum bus at slightly elevated temperatures (100 C) has little if any harmful effect upon its tensile strength.

11. At subzero temperatures the strengths of aluminum bus are higher than at atmospheric temperature, with no evidence of embrittlement.

12. In resistance to creep, *61S-T6* is superior to *63S-T6*, which in turn is superior to *EC* bus.

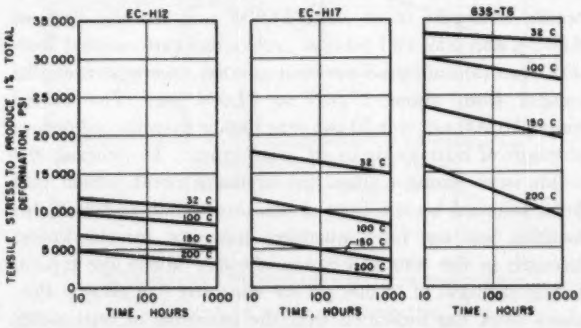

Fig. 10. Creep resistance of aluminum bus

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Harmonic Cancellation From Computing Voltage Source in Servo Analogue Computers

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ASSOCIATE MEMBER AIEE

A system where harmonics that appear on the computing voltage source of a servo analogue computer may be cancelled out in the summing network of the servo amplifier is described. This is accomplished by the injection of harmonics into the quadrature rejection circuit of the servo system.

SERVO SYSTEMS using an a-c carrier frequency become subject to disorders caused by harmonic voltages appearing on the computing voltage. These harmonics, or "noise," tend to degrade the servo system. Due to unwanted voltages appearing at the servo amplifier input, the noise causes saturation of the servo amplifier. The previously mentioned harmonics of the carrier also cause the servo amplifier to lose its effective gain, or lower the kv of the servo system. Furthermore, the kv now becomes a function dependent on the level of the harmonic voltages present in the servo system. This makes the kv an unknown factor in the servo system.

The system described in this article is not necessary in servo systems where the gain is not high enough to cause saturation of the amplifier by harmonic voltages, or where saturation is eliminated by computing voltage sources sufficiently clear of harmonics. However, this system can be used to advantage when harmonics that appear in the computing voltage cannot be sufficiently attenuated by filters because the harmonics are too close to the carrier frequency of the system.

A special article recommended for publication by the AIEE Committee on Computing Devices.

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BLOCK OPERATION

THE system shown in Fig. 1 uses computing elements that may consist of potentiometers, resolvers, amplifiers, etc. The summing network consists of matched resistors. The quadrature rejection system consists of a potentiometer driven by a motor sensitive only to a 90° phase or quadrature voltage out of the servo amplifier.

OPERATION ANALYSIS

IF the transformation ratio of a typical computing network containing an amplifier, resolver, and associated parts is examined, a curve like the one shown in Fig. 2 will be formed. This curve may be approximated with an equivalent curve of a low Q circuit which is tuned to a much higher frequency than that used by the servo carrier frequency. This circuit is illustrated in Fig. 3. It should be noticed that a similarity exists between this circuit and that of an equivalent circuit of a transformer whose transformation ratio is for low frequencies.

$$\frac{E_2}{E_1} = \frac{j\omega L_M}{R_1 + j\omega L_M} \tag{1}$$

$$\frac{E_2}{E_1} = \cos \phi_L \angle \phi_L \tag{2}$$

where

$$\phi_L = \tan^{-1}\left(\frac{R_1}{\omega L_M}\right) \tag{3}$$

For higher frequencies,

$$\frac{E_2}{E_1} = \frac{\frac{1}{j\omega C_1}}{R_1 + j\left(\omega L_g - \frac{1}{\omega C_1}\right)} \tag{4}$$

and

$$\phi_H = -\tan^{-1}\left[\frac{\frac{1}{Q_o}}{\left(\frac{\omega_o}{\omega}\right)-\left(\frac{\omega}{\omega_o}\right)}\right] \quad (5)$$

where ω_o is the resonant frequency of L_S and C_1, and Q_o is the Q at the resonant frequency.

By the use of the superposition theorem,

$$\phi = \phi_L + \phi_H \quad (6)$$

where ϕ is the phase shift of this circuit at any frequency, ϕ_L is the phase shift due to components which affect the circuit at low frequencies, and ϕ_H is the phase shift due to components which affect the circuit at high frequencies.

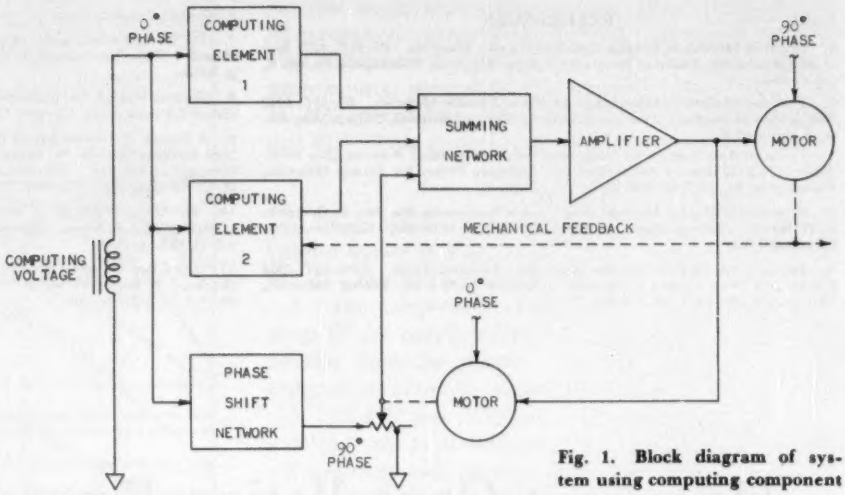

Fig. 1. Block diagram of system using computing component

$$\phi = \tan^{-1}\left(\frac{R_1}{\omega L_M}\right) - \tan^{-1}\left[\frac{\frac{1}{Q_o}}{\left(\frac{\omega_o}{\omega}\right)-\left(\frac{\omega}{\omega_o}\right)}\right] \quad (7)$$

By limiting L_M as a large inductance, and ω_o as a frequency much higher than being considered, the tangent of the angle may be replaced by the angle and the result would be

$$\phi = \frac{R_1}{\omega L_M} - \frac{\frac{1}{Q_o}}{\left(\frac{\omega_o}{\omega}\right)-\left(\frac{\omega}{\omega_o}\right)} \quad (8)$$

By taking each term of the equation separately, and using ω_o as being much higher in frequency than the break point of R_1 and L_M, the first term of equation 8 may be considered. The result would be

$$\phi = \frac{R_1}{\omega L_M} \quad (9)$$

Using a general equation for computing voltage,

$$E = A_1 \sin(\omega t) + A_2 \sin(2\omega t) + A_3 \sin(3\omega t) + \ldots \quad (10)$$

the phase shift ϕN which occurs through a computing network for each of the frequencies or harmonics can be solved.

$$\phi F = \frac{R_1}{\omega L_M},\ \phi_2 = \frac{R_1}{2\omega L_M},\ \phi_3 = \frac{R_1}{3\omega L_M} \quad (11)$$

In the summing network of a servo system, two computing voltages are subtracted to comprise the null voltage.

Computing Voltage No. 1:

$$E_1 = \left[A_1 \sin\left(\omega t + \frac{R_1}{\omega L_M}\right) + A_2 \sin\left(2\omega t + \frac{R_1}{2\omega L_M}\right) + A_3 \sin\left(3\omega t + \frac{R_1}{3\omega L_M}\right) \ldots\right] \quad (12)$$

Computing Voltage No. 2:

$$E_2 = \left[A_1 \sin\left(\omega t + \frac{R_a}{\omega L_a}\right) + A_2 \sin\left(2\omega t + \frac{R_a}{2\omega L_a}\right) + A_3 \sin\left(3\omega t + \frac{R_a}{3\omega L_a}\right) \ldots\right] \quad (13)$$

In network *1*, R_1 and L_M correspond respectively to R_a and L_a in network *2*.

Null Voltage:

$$E_1 - E_2 = \left[2A_1 \sin K \cos(\omega t + Q) + 2A_2 \sin\frac{K}{2} \cos\left(2\omega t + \frac{Q}{2}\right) + 2A_3 \sin\frac{K}{3} \cos\left(3\omega t + \frac{Q}{3}\right) \ldots\right] \quad (14)$$

where

$$K = \frac{R_1}{2\omega L_M} - \frac{R_a}{2\omega L_a} \quad (15)$$

and

$$Q = \frac{R_1}{2\omega L_M} + \frac{R_a}{2\omega L_a} \quad (16)$$

Considering $K \ldots . NK$ as a small number, we can substitute K for sin K,

$$E_1 - E_2 = \left[2A_1 K \cos(\omega t + Q) + 2A_2 \frac{K}{2} \cos\left(2\omega t + \frac{Q}{2}\right) + 2A_3 \frac{K}{3} \cos\left(3\omega t + \frac{Q}{3}\right) + \ldots.\right] \quad (17)$$

$$K = \frac{R_1}{2\omega L_M} - \frac{R_a}{2\omega L_a} = \frac{B_1 + B_2}{2\omega} \quad (18)$$

Therefore,

$$E_1 - E_2 = \left[D_1 \frac{B_1+B_2}{2\omega} \cos(\omega t + Q) + D_2 \frac{B_1+B_2}{4\omega} \cos\left(2\omega t + \frac{Q}{2}\right) + D_3 \frac{B_1+B_2}{6\omega} \cos\left(3\omega t + \frac{Q}{3}\right) + \ldots.\right] \quad (19)$$

From equation 19 it can be determined that the amplitude of each harmonic is an integer dependent on the constants $B_1 + B_2$. To accomplish a better null, a voltage

must be introduced into the servo summing network which is the negative of equation 19. This voltage is of the form,

$$E_x = -D_1 \cos(\omega t) - \frac{1}{2} D_2 \cos(2\omega t) - \frac{1}{3} D_3 \cos(3\omega t) - \ldots . \quad (20)$$

where

$$D_1 = PA_1$$
$$D_2 = PA_2 \quad (21)$$
$$D_3 = PA_3$$

The circuit necessary to transform the computing voltage E_1 of equation 10 to E_x of equation 20 is shown in Fig. 4.

Considering the second term of equation 8, we have

$$\phi = \frac{\frac{1}{Q_o}}{\left(\frac{\omega_o}{\omega}\right) - \left(\frac{\omega}{\omega_o}\right)} \quad (22)$$

where

$$\frac{1}{\omega_o Q_o} = C\omega \quad (23)$$

and if

$$\frac{\omega}{\omega_o}$$

is considered small, we have

$$\phi = C\omega \quad (24)$$

The computing voltages at the summing network would be of the form

$$E_1 = [A_1 \sin(\omega t + C\omega) + A_2 \sin(2\omega t + 2C\omega) + A_3 \sin(3\omega t + 3C\omega) + \ldots .] \quad (25)$$

$$E_2 = [A_2 \sin(\omega t + C_1\omega) + A_2 \sin(2\omega t + 2C_1\omega) + A_3 \sin(3\omega t + 3C_1\omega) + \ldots .] \quad (26)$$

where C and C_1 are constants dependent on the components in computing networks *1* and *2*.

The null voltage resulting from the addition $E_1 - E_2$ would be

$$E_1 - E_2 = [2A_1 \sin F \cos(\omega t + H) + 2A_2 \sin 2F \cos(2\omega t + 2H) + 2A_3 \sin 3F \cos(3\omega t + 3H) + \ldots .] \quad (27)$$

where

$$H = \frac{C\omega}{2} + \frac{C_1\omega}{2} \quad (28)$$

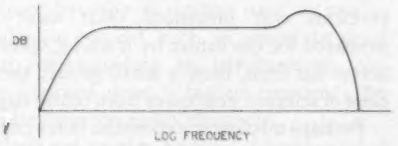

Fig. 2. Frequency response of computing element

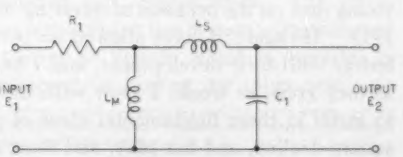

Fig. 3. Equivalent circuit of computing network

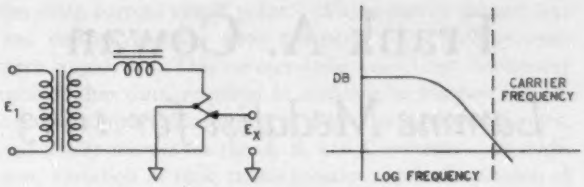

Fig. 4. Q_E circuit

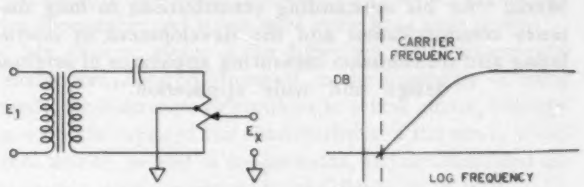

Fig. 5. Quadrature rejector circuit

and

$$F = \frac{C\omega}{2} - \frac{C_1\omega}{2} \quad (29)$$

Since sine $F \ldots . NF$ will always be a small angle, F can be substituted for sine F.

$$E_1 - E_2 = [2A_1 F \cos(\omega t + H) + 2A_2\, 2F \cos(2\omega t + H) + 2A_3\, 3F \cos(3\omega t + 3H) + \ldots .] \quad (30)$$

But,

$$F = \frac{C\omega}{2} - \frac{C_1\omega}{2} = \frac{\omega}{2}(C + C_1) \quad (31)$$

By substituting in equation 30 we have

$$E_1 - E_2 = \left[D_1 \frac{\omega}{2}(C + C_1) \cos(\omega t + H) + D_2 \omega (C + C_1) \cos(2\omega + 2H) + D_3 \frac{3}{2}\omega (C + C_1) \cos(3\omega t + 3H) + \ldots . \right] \quad (32)$$

From this equation, it should be noted that the amplitude of each harmonic is an integer dependent on the constants C and C_1. The negative of this voltage is that which is necessary to be supplied to the summing network to achieve a better null at the servo amplifier. This voltage is of the form

$$E_x = -D_1 \cos(\omega t) - 2D_2 \cos(2\omega t) - 3D_3 \cos(3\omega t) \ldots . \quad (33)$$

The circuit necessary to transform the computing voltage E in equation 10 to E_x in equation 33 is shown in Fig. 5.

CONCLUSION

This article emphasizes the fact that it is possible to make use of the quadrature rejector circuit for the cancellation of harmonics that originate at the source of the computing voltage. It also points out that the system used for harmonic cancellation is dependent on the frequency response of the computing network. In either case, the knowledge of what type of frequency response is obtained by the computing network determines the type of quadrature rejection circuit to be used.

This analysis is valid only when there is very little phase shift at the frequencies considered.

Frank A. Cowan

Lamme Medalist for 1953

Frank A. Cowan of the American Telephone and Telegraph Company has been awarded the 1953 Lamme Medal "for his outstanding contributions to long distance communication and the development of modulating and transmission measuring apparatus of original design and wide application."

The Establishment of the Medal

A. C. MONTEITH
FELLOW AIEE

I AM HAPPY to outline the background of the Lamme Medal, and to tell something about the famous engineer who created it.

To me, this occasion has double significance. First, it brings back to me my days as a student in one of the last design courses taught personally by Mr. Lamme at Westinghouse. Second, I feel fortunate to be on the Lamme Medal Committee this year, and to have had a part in selecting a recipient of whom I am confident Mr. Lamme would be proud.

The Lamme Medal was a bequest to AIEE in the will of Benjamin Garver Lamme, and the 1953 medal is the 26th to be awarded to a distinguished member of the Institute.

Mr. Lamme was a design and development engineer all of his life. He felt strongly that design engineers needed not only encouragement and inspiration at home, but also nation-wide recognition by their engineering profession for outstanding achievement. Thus, the Lamme Medal is awarded only to AIEE members who have "shown meritorious achievement in the development of electrical apparatus and machinery." Any work that results in substantial advancement of the art is eligible, whether it be concerned with the development of (*a*) theory, (*b*) materials, (*c*) over-all design, or (*d*) in other ways that produce major technical advancement.

One fact not always appreciated by members of the Institute is that the Lamme Medal covers an extremely broad field of design. It is not confined to developments only in the rotating machinery art where Mr. Lamme was so prominent. The key words in the bequest, "electrical apparatus or machinery," mean discrete and self-contained devices that may or may not include mechanical moving parts, without limitation as to the field of application. Thus, while the Lamme Medal has been awarded to many designers in Mr. Lamme's own field of rotating machinery, it also has been bestowed on designers of many diversified devices, including instruments, relays, circuit interrupters, regulating apparatus, and television equipment. This year, for example, we are honoring an outstanding engineer for his technical development of devices for improving long-distance communication in the telephone field.

The obverse of the Lamme Medal is inscribed, "The Engineer Views Hopefully the Hitherto Unattainable." These are Mr. Lamme's own words, and are symbolic of the man who gave inspiration to so many engineers. To me, these words express the essence of his own personal creed as a designer, and his abiding faith in the creative ability of future engineers of the Institute.

Mr. Lamme's brilliant pioneering in electrical design has been told many times and is well recorded. So I am going to pass over that aspect and stress two of his admirable personal traits that are less well known and perhaps have significance for all of us today—his engineering optimism and his forehandedness.

Throughout his career Mr. Lamme was an optimist in facing up to difficult technical problems. In that early day he had to be, to achieve so much with so little technical knowledge at hand. To him, a difficulty was an opportunity; and a failure was a challenge to find a new way. I believe this basic attitude was responsible to a large degree for many of his epoch-making design accomplishments.

All through his life, Mr. Lamme was forehanded. He practiced being ready for the future. He cultivated habits of study and methods of work that would be useful later on. In his later years he systematically anticipated future technical needs and often had a solution ready when a problem was presented. But most fundamentally he prepared for the future by training others; first an assistant across his desk, then a small group, then annually a large class of selected graduates from many engineering schools.

Perhaps no clearer exposition of his character can be made than is given by a statement of his own regarding these young men on the occasion of receiving the Edison Medal in 1919. He said: "I have allowed no petty jealousies to interfere with their development, and I have always felt that as they grew, so would I grow with them. I have aimed to instill in them fundamental ideas of engineering ethics, square dealing, and fair play, and there should be pride in

Presentation and acceptance addresses given at the Lamme Medal ceremony held during the AIEE Summer and Pacific General Meeting, Los Angeles, Calif., June 21–25, 1954.

A. C. Monteith, Westinghouse Electric Corporation, Pittsburgh, Pa., and President of the Institute for 1954–55, is chairman of the Lamme Medal Committee.

accomplishment, and that true engineering means much more than making a living—that it means advancement of the art for the benefit of mankind."

To me, in a broad sense this medal that the Institute bestows is a living symbol to carry ever forward among engineers these principles in which Benjamin Garver Lamme believed, and by which he lived.

Career of the Medalist

J. J. PILLIOD
FELLOW AIEE

FRANK A. Cowan was born in Escatawpa, Ala., and just 35 years ago completed one phase of his education while still a resident of the South. For this achievement he received, in 1919, the degree of bachelor of science in electrical engineering from the Georgia Institute of Technology. Working out of Atlanta for 3 years, in the long lines department of the American Telephone and Telegraph Company, introduced him to the broad field of electrical communications. An evident showing of interest in that field and of technical ability in this period contributed to an opportunity to transfer to the engineering department of long lines in New York, N. Y., in 1922.

With that city as a base, Mr. Cowan has since continued his work in communications engineering in positions of increasing responsibility, and is now assistant director of operations—engineering, of the long lines department of the American Telephone and Telegraph Company. He has made important contributions and inventions which have resulted in reduced costs and improved telephone and telegraph service to this and other countries. He has participated actively in business management matters and in professional fields.

Having in mind that the donor of the Lamme Medal intended that it be awarded annually to a member of the Institute for "meritorious achievement in the development of electrical apparatus or machinery," it, perhaps, will be appropriate to select and describe, briefly, two of Mr. Cowan's more important electrical inventions included in a list of 17 issued patents.

Modulating Systems of a New Type. The first relates to modulators and demodulators of a type employing rectifiers and now used widely in wire and radio communications systems in the United States and abroad. Modulators may be described broadly as devices used to modulate or modify an electric current such as would be done in causing currents corresponding to telephone or telegraph signals to be imposed upon a higher frequency for transmission over wire lines or radio channels.

In the earlier telephone carrier systems, vacuum tubes were used as modulators and demodulators. The variation in instantaneous transmission loss or gain with changing amplitude of the carrier or signals, which is essential to modulation, was achieved by biasing the tubes nearly to the plate current cutoff point. Where carrier suppression was desired, circuits with balanced tube arrangements were employed. This vacuum-tube modulator, commonly used at that time, required in addition to the two tubes a balanced input transformer, a similar output transformer, and power sources for the *A*, *B*, and *C* voltages. In addition, variation in tube characteristics required selection of tubes to obtain adequate balance, and tests and adjustments to maintain the balance.

Because of this complexity, searches for something simpler yet dependable and stable were made from time to time.

Mr. Cowan, aware of the difficulties with vacuum-tube modulators, became interested in the possibility of using nonlinear resistances or rectifiers in a new circuit arrangement. He explored the characteristics of the newly available thyrite, as well as copper oxide, and demonstrated the operation of a copper-oxide modulator on a type *C* (3-channel) carrier system. On May 22, 1934, Patent No. 1,959,459 was issued to him on the bridge-type modulator employing nonlinear rectifier elements, such as copper oxide. On December 24, 1935, Patent No. 2,025,158 was also issued to him, covering the ring-type modulator. These two modulator circuits have found a wide field of use in this country and elsewhere in the world. The simpler bridge arrangement, which suppresses the carrier but permits the modulating signal to pass, is used principally for individual channel modulation and demodulation. The ring type is used where suppression of the modulating signals, as well as of the carrier, is desired such as in modulators for groups of channels. In this case only the products of modulation are transmitted.

While improvements have been made in the copper-oxide units used in the modulators covered by the original invention, the basic circuits and arrangements are still applicable. It is estimated that in the United States alone, well over one million of these modulators are now in use in carrier telephone, telegraph, and radio systems. A great saving in over-all costs is effected as contrasted with the earlier method using vacuum tubes and their associated power supply for modulators, and better service is possible.

Signal-Distortion Measuring Device. The second invention covers a signal-distortion measuring device covered by patents issued September 13, 1938, and October 11, 1938.

Mr. Cowan, in his work as transmission engineer of the long lines department, took particular interest in telegraph transmission and pioneered in the development of new and novel arrangements for measuring telegraph transmission.

In telegraph transmission it is the accuracy of the time intervals between transitions in the received line signals which determines the capabilities of a telegraph system. Mr. Cowan's telegraph transmission measuring set provided novel means for accurately measuring the per-cent distortion of the received signals by employing a capacitor-charging principle for time measurement. The voltages acquired by small capacitors, which are charged at a constant rate during the time intervals to be measured, are compared with a reference voltage. The complete measuring set, which was personally worked out, and a working model built by Mr. Cowan, comprises a comparison circuit,

J. J. Pilliod, retired; formerly with the American Telephone and Telegraph Company, New York, N. Y. He is now a consulting engineer.

a constant current supply, a rectifying peak voltmeter, and a calibrating circuit. This set provided a marked improvement over previous telegraph transmission measuring devices in several particulars, as follows:

1. It provided a very high degree of accuracy.
2. It was the first to measure telegraph transmission distortion with random signals on a working circuit.
3. Indications of distortion were obtained directly on meters. This also provided for remote indication and control.
4. It provided a means for measuring independently both fortuitous distortion and signal bias.

This telegraph transmission measuring set was standardized by the Bell System practically in the form originally built by Mr. Cowan. It has been very extensively used throughout the Bell System, and by others, and has played an important part in improving the transmission of telegraph circuits used extensively today in the teletypewriter exchange system and vast private-wire teletypewriter networks covering the nation.

Mr. Cowan's early assignments involved him in transmission testing methods and field trials of new long-distance communications systems. He was also concerned with the development of such special services as network radio and video program transmission, overseas radiotelephony, and the transmission of pictures by wire. In 1928, Mr. Cowan was appointed engineer of transmission for the long lines department of the American Telephone and Telegraph Company. In 1940, he was placed in charge of the transmission section of the operation and engineering department. Nine years later, Mr. Cowan returned to long lines where he is in charge of the engineering staff.

Mr. Cowan has made several trips abroad on communications matters. In 1946, he was the United States Delegate at meetings of the International Consulting Committee on Telephony (CCIF), attending both a spring meeting in Paris, France, and the plenary session held at Montreux, Switzerland, the following fall.

Mr. Cowan, who is a Fellow of the AIEE, was a member of the Technical Program Committee for 4 years, and served as chairman for 2 years. He was also the chairman of the AIEE Prize Award Committee for 2 years, and was chairman of the Communications Group, New York Section, for 1 year. He is also a senior member of the Institute of Radio Engineers. Mr. Cowan has had a number of papers on telephone subjects published.

The foregoing portrayal of a few highlights of Mr. Cowan's professional career would seem to qualify him well for the award of the Lamme Medal under the terms suggested by the donor. There are other characteristics, however, of the medalist which should be included in closing. Mr. Cowan was directly associated with the author for the periods 1928 to 1940 and 1943 to 1949, or more than half his professional career to date. A personal appraisal of his career, particularly during these periods, and one which I am confident is shared by his acquaintances, is that his individual contributions to electrical engineering and associated fields constitute a rich fund of creative and sound ideas. Ideas influence actions, and so ideas must always precede and underlie progress. Mr. Cowan's career is studded with ideas. Many important ones are in the field of electrical invention, but others lie in the broader fields of communication and have to do with such diverse matters as engineering problems related to utility regulation, studies of comparative costs, and specific problems which continuously arise in the future planning, as well as day-to-day operation of large utility organizations, such as exist in the telephone industry.

In order to be concrete, a few specific illustrations will be given of the types of engineering projects with which Mr. Cowan has been closely and personally associated:

1. Application of carrier telephone and telegraph systems throughout the United States.
2. Engineering of long-distance cable systems, including coaxial cables from coast to coast, and throughout the country.
3. Engineering of microwave radio-relay systems on a nation-wide basis for telephone and television network service.
4. Radio systems for telephone service from the United States to points throughout the world.
5. Plans for telephone cable between North America and Great Britain.

Many more engineering projects could be listed. Individually, and in total, they are impressive but there are other characteristics of the medalist which must be touched upon here. They may be summarized briefly as follows:

1. Intense interest in the work at hand, and in people.
2. Ability to study a problem.
3. Co-operation with many people, thus learning from others, and imparting knowledge and help to others.
4. A striving for optimum performance of electric apparatus and systems, and the avoidance of any inadequacy or waste in design or operation to the end that the best possible service to the public could be furnished.
5. Leadership and ability to select and inspire people for jobs to be done.

I am glad to present Frank A. Cowan, the Lamme Medalist for 1953, and an electrical engineer with achievements of outstanding significance to his credit and to the credit of the engineering profession.

Imagination in Engineering

F. A. COWAN
FELLOW AIEE

IT IS a great privilege and an honor to receive the Lamme Medal, and I am very grateful. Its importance is emphasized by the accomplishments of the men who have received this award in the past. To be included in this group makes me both proud and humble. Although the award is made to me as an individual, the work on which it

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is based would not have been possible without the help and co-operation of many people. It was my good fortune to have been associated with an organization which provided both opportunity and support. In accepting the medal, I wish to acknowledge the help of my associates who, over the years, have been a continuing source of encouragement and assistance.

While in college I spent one summer with the Westinghouse Electric Corporation in East Pittsburgh, Pa. I did not meet Mr. Lamme but it was there, working within the climate he had created, that I reaffirmed my determination to make a career of engineering.

Naturally, this award has led to some retrospective thinking. From this review I have been impressed by the importance of imagination and increasing volume in stimulating the development and use of new and improved systems. We can also say that the development and use of new systems stimulates imagination and growth. For an engineer perhaps the most important of these interrelated factors is imagination. Imagination may serve either to mask reality, or to penetrate and clarify it. Traditionally, the engineer is supposed to keep his feet firmly planted on the ground and avoid flights of fancy. Spurred on by intellectual curiosity he would be expected to look into a case with microscope rather than rose-colored glasses. On the other hand, there are times when the inspiration of the elusive rainbow is to be preferred to the cold analytical approach. The mature mind may well use flights of fancy to avoid the quagmire of orthodox thinking.

A fine example of imagination is found in the articles of incorporation of the American Telephone and Telegraph Company, established in 1885, just a few years after the invention of the telephone. Among the stated objectives of the corporation is, "To connect one or more points in each and every city, town or place in the State of New York with one or more points in each and every other city, town or place in said State, and in each and every other of the United States, and in Canada and Mexico, and each and every of said cities, towns and places is to be connected with each and every other city, town or place in said States and Countries, and also by cable and other appropriate means with the rest of the known world as may hereinafter become necessary or desirable in conducting the business of this association." I do not know who was the author of this statement. No matter whether he was a lawyer, businessman, poet, or engineer, he established an imaginative goal which has been an inspiration to telephone engineers.

The immediate task facing the founders of the company was the provision of long-distance lines to connect the scattered local exchanges, and thus provide an integrated telephone service. The range of the telephone was limited in 1885 to a few hundred miles even when the recently developed hard drawn copper wires 0.104 inch in diameter were used in place of steel. By the use of 0.165-inch copper wire, the range was more than doubled, and Chicago, Ill., came within reach of the eastern seaboard by the time of the Chicago World's Fair in 1893. By the application of loading coils (inductance inserted in series with the line about every 8 miles) the long-distance network was extended as far west as Denver, Colo., by 1911. In order to avoid

President Robertson (left) presents the Lamme Medal citation to Mr. Cowan. Looking on are President-Elect Monteith and, far right, H. H. Henline

the extra loss in speech volume caused by cable, the main trunk routes were not carried into the intermediate cities. This required the construction of switching and test stations outside the larger cities. All of these steps were in the direction of increasing costs and the limit of practical application was being reached. Still, the Pacific and and Atlantic Coasts were not connected.

What was needed was an amplifier. Some use was made of a mechanical repeater (a receiver coupled to a transmitter) but the distortion was high and the field of use limited. Dr. Lee de Forest invented the 3-element vacuum tube in 1907 while working on radio. This tube was tried in place of the mechanical amplifier but the output power was not adequate for telephony at that time. By 1915 it had been improved to a point where it could be applied to the loaded 0.165 copper wires which furnished the first transcontinental telephone service. This service was demonstrated at the Panama-Pacific exposition in 1915.

Vacuum-tube amplifiers simultaneously opened two other fields for telephony which were to affect its future profoundly; namely, carrier and radio. These new fields were just coming into use at the end of World War I. Starting in 1919 long-distance telephony experienced 35 years of rapid and almost uninterrupted growth and service improvement. Telephone repeaters, carrier, and radio were among the tangible ingredients which made this possible. Another ingredient was the imagination displayed by the management of the long lines department of the American Telephone and Telegraph Company. They realized that the most effective use of amplifiers, carrier, and radio depends upon having use for a much larger number of circuits over an average route than had been needed in the past.

When equipped with voice frequency amplifiers, cables containing hundreds of pairs of fine-gauge copper wires become practical. With carrier, as many as 16 telephone circuits may be obtained from a single pair of wires on an open-wire line, even though they are the smallest that have

sufficient mechanical strength for use in the open. Again, by carrier means, television circuits, and hundreds or even thousands of circuits can be obtained from a special structure of cable conductors, such as the coaxial. Radio may be used for mobile service, to span oceans, or to provide television circuits and hundreds of telephone circuits along radio-relay routes between fixed points.

The number of telephone circuits over the average long-distance telephone route was 25 in 1919; today it has grown to 500. Among the reasons for this increase was a new operating procedure and a new approach in circuit provision arising from a new concept of the advantages and growth which might follow faster and better telephone service.

Up until the middle 1920's it had been the practice, in handling long-distance calls, for one operator to make a record of the customer's request, release the customer, and then another operator would establish the connection later. While this method of operation provided an opportunity to obtain a more uniform traffic load, it did not promote fast handling of calls. The average time required for completing a long-distance call was then over 10 minutes. In 1925, when the cable and carrier techniques were beginning to be applied in volume, arrangements were made to increase the number of circuits connecting New York with Chicago; Cleveland, Ohio; Detroit, Mich.; Philadelphia, Pa.; Washington, D.C., and Boston, Mass. The number of circuits provided was well above those provided under previous engineering practice. Special attention was given to the maintenance of these circuits to insure the minimum of lost time due to circuit trouble. The improvement in the speed of service thus made possible was well received by the public and, before long, the plan was extended to other groups. With this more liberal circuit provision it became possible to introduce a new operating plan, in which the operator would attempt to complete the call at the time the customer makes his initial request. Even with the liberal provision of circuits, some of the calls would encounter an "all-circuits-busy" condition on the initial attempt and later attempts would be necessary. By 1930 the percentage of calls on which this condition was encountered had dropped to less than 4 per cent. This figure may be compared with practically 100 per cent customers released a few years before. The average time required to establish a connection had dropped to 2.6 minutes.

It is significant that this improved speed of service was achieved with an average load of 8,500 messages annually per circuit, whereas in 1925 the load was only 6,250. In 1953 the average connection required only 2.2 minutes with 9,600 messages per circuit annually. This increase in efficiency in over-all use along with service improvement was made possible, primarily, by the great increase in the number of circuits in the average circuit group. With the same probability of encountering delay due to an "all-circuits-busy" condition, a circuit group made up of 15 circuits may be used for one third more messages per circuit in the busy hours than a group made up of five circuits. Another factor of importance is minutes of circuit use per message. Although long-distance customers now talk half again as long as previously, there has been a compensating reduction in operator use of the circuits due to more efficient operating procedures and dialing of many calls.

In 1953 the number of long-distance messages handled was 25 times as great as in 1919, while the population of this country had increased only about one half. The service improvement, increased usage, greater efficiency, and lower over-all costs due to the opportunity of using the new system permitted a series of reductions in long-distance telephone rates. This chain of events might never have got under way nor progressed as far had not the management had the courage to make the initial seemingly over-liberal provision of facilities.

TRANSATLANTIC TELEPHONE

So far, we have considered the domestic development of long-distance telephony. Let us now consider connections to the "rest of the known world" by "cable or other appropriate means." Although the Atlantic had been spanned by telegraphic cable before 1885, the nature and magnitude of the job of building a cable for transoceanic speech transmission was such that a great deal of development was needed. Here again amplifiers were needed but they had to be able to operate under 2 or 3 miles of water. Twenty-five years ago, the general state of communications development was sufficiently advanced to encourage the start of research and development directed specifically toward this goal. In 1950 a cable system using deep-sea-type repeaters was placed between Key West, Fla., and Havana, Cuba. The system has operated without amplifier trouble to date. Construction work on the first transatlantic telephone cable started this year, and it is expected to be completed in 1956.

Radio transmission which has served as one of the "other appropriate means" was not known in 1885 when the objective was stated. The possiblity of the existence of radio waves had been suggested 20 years earlier by Maxwell's now famous wave equations. Hertz was yet to prove the existence of electromagnetic waves, and about 20 years more were to pass before Marconi put these waves to use in communication.

It seems clear that the "other appropriate means" was based primarily on faith and hope, rather than specific knowledge. Time has shown that this faith was justified. It was 1915 when speech first crossed the Atlantic, using radio made possible by the vacuum tube. In 1927 telephone service was initiated between New York and London, England, by radio. Today, 96 per cent of the world's telephones are within reach of the telephone user in the United States.

The important point I see in the foregoing is that, although faced with many obstacles—some known and many unknown—the framers of these articles of incorporation had the imagination and courage to go beyond the immediately practical, and set high objectives for the future.

Certainly today, with so much more in engineering knowledge, we should look confidently to a future in which the scope of communications have been broadened to include many types of services now unknown. Let us hope that improved understanding between people will be one of the results of tomorrow's improved communications.

Selenium Rectifier Instantaneous Characteristics

G. F. PITTMAN, JR.
ASSOCIATE MEMBER AIEE

IN POWER APPLICATIONS of selenium rectifiers the reverse characteristics of the selenium cell are of interest only in so far as they affect the heat generated within the the cell and thus the efficiency and the current rating of the cell as dictated by its heat dissipation capabilities. In more critical applications, however, the detailed reverse characteristics of the cell must be considered. In such applications, not only a more complete knowledge of the reverse resistive properties of the cell is required, but also information regarding its capacitive properties.

Through an experimental study of the instantaneous reverse voltage-current operating loci of selenium cells at power frequencies, much information as to the nature and magnitudes of these reverse characteristics may be obtained. This information, in turn, provides an insight into the effects of these characteristics upon the operation of selenium rectifying elements and, also, upon methods of testing cells to be used in critical applications. This article presents some results of such a study; relatively long-term effects such as aging, temperature drifts, forming, etc., are not considered, but, rather, attention is focused upon phenomena taking place within a given cycle of operation.

By applying the voltage across the cell to the horizontal axis of an oscilloscope and a voltage proportional to the cell current to the vertical axis, the instantaneous operating voltage-current loop of the cell under the operating conditions imposed may be displayed. The figure shows two such loops obtained with a full-wave rectified sinusoidal voltage applied to the cell in its reverse direction; cell voltage and current waveforms also are shown.

A notable feature of the operation observed is that, although the voltage applied to the cell is at all times acting in the reverse direction, a current in the forward direction flows during a large part of the cycle. This behavior is explained readily if the rectifier is thought of in terms of an equivalent circuit consisting of a purely capacitive element in parallel with a purely resistive element. (This is indeed a very simplified equivalent circuit; however, experimental evidence justifies its use under many normally encountered operating conditions.) The equivalent differential capacitance of the cell is a nonlinear function of the instantaneous voltage applied to the cell, having relatively high values at the near zero voltage and decreasing rapidly as the voltage increases in the reverse direction. The reverse differential resistance characteristic also shows a decreasing trend with increasing reverse voltage. Both the resistive and capacitive characteristics of a cell are found to be relatively independent of the frequency of the alternating supply voltage used over a wide range. It should be noted, however, that the resistive characteristic determined under a-c or rectified a-c operating conditions is not the same as that obtained using pure direct current.

With typical values of the equivalent parameters and the nature of their nonlinearities in mind, more careful consideration may be given the operation of selenium cells in critical applications where the reverse characteristics of the cells are of importance. This is especially true for applications such as the self-saturating or feedback rectifiers of magnetic amplifiers where the instantaneous reverse voltage may exhibit abrupt changes in magnitude. A recognition of the detailed reverse characteristics also makes possible an accurate evaluation of methods and conditions used in testing cells for such applications.

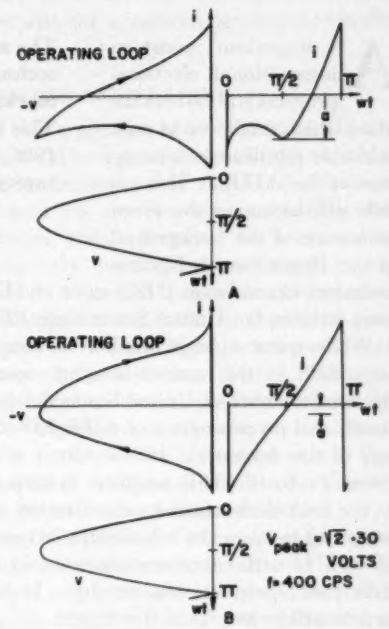

Fig. 1. Instantaneous cell operation with full-wave rectified sinusoidal reverse voltage applied

A—a-c source frequency of 60 cycles; B—400 cycles

In conclusion it has been determined that the electrical properties of selenium rectifiers in the reverse direction may be conveniently represented by an equivalent parallel combination of a nonlinear resistor and a nonlinear capacitor for many engineering purposes. Both the resistance and differential capacitance show a decreasing trend with increasing reverse voltage while, to a good approximation, both parameters may be considered independent of the frequency of applied voltage.

In critical applications, the existence of both resistive and capacitive effects must be recognized and their magnitudes and variations considered if a realistic understanding of the rectifier operation and its effect upon the remainder of the circuit is to be had.

Digest of paper 54-164, "Instantaneous Electrical Characteristics of Selenium Rectifiers," recommended by the AIEE Committee on Metallic Rectifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Published in AIEE *Communication and Electronics*, March 1954, pp. 45–9.

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The IEC Marks Its Golden Jubilee

R. C. SOGGE
FELLOW AIEE

The annual meeting of the International Electrotechnical Commission in Philadelphia this year marks the organization's 50th anniversary. This meeting, the first in the United States since 1926, will give many AIEE members the opportunity to participate in discussions of international electrical standardization.

AN important event in international electrical progress is about to take place which should be of considerable significance to members of the AIEE. This article will document the event with some of the background of the International Electrotechnical Commission (IEC) since an IEC meeting has not been held in the United States since 1926.

While quite a large number of annual meetings have been held in the various member countries of Europe, the total number of United States delegates has been very small, and no committee of AIEE has officially nominated any of the delegates. It is a matter of some importance, therefore, to all AIEE members to keep abreast of progress in the field of electrical standardization on an international basis and to know the relationship between AIEE and IEC as well as with other organizations in the United States that participate in this activity. It is hoped that this article will be helpful in this regard.

The IEC annual meeting this year in Philadelphia, Pa., from September 1 to September 16, will provide an opportunity for many AIEE members, who are active in committee work on one or more of the technical projects, to attend some of the technical sessions, the Jubilee Day program, and other events.

FORMATION OF THE IEC

IT IS quite fitting that the 50th anniversary be celebrated in the United States and that the Institute and its members take an active interest in this matter. First, it will be 50 years since the IEC was started in St. Louis, Mo., when the impressive list of names on the 1904 Reception Committee contained many prominent AIEE members. The history which led to the formation of the IEC records that a series of International Electrical Congresses in 1881, 1893, 1896, and 1900 had brought together leading electrical engineers from many countries and had done much in the matter of international agreement on units and standards of measurements. It was recognized, however, that there was a need for a permanent body designed to give methodical and continuous study to problems of standardization in the electrotechnical field, and at the Congress of St. Louis in 1904, the Chamber of Government Delegates recommended "that steps should be taken to secure the co-operation of the technical societies of the world by appointment of a representative commission to consider the question of standardization of the nomenclature and ratings of electrical apparatus and machinery."

The new body was soon organized, and held its first conference in London, England, in 1906, under the auspices of the Institution of Electrical Engineers, which is the body in England corresponding to AIEE. Lord Kelvin was elected its first president.

Except for the war years, the Commission has held numerous meetings and a substantial number of important international standards have been produced.

IEC standardization covers practically every branch of the electrotechnical field. One of its most important projects is the unification of electrotechnical nomenclature through the publication of an international vocabulary in several languages and agreement on units and quantities used in electricity. The second major division of IEC work is the preparation of standards for electric machinery and apparatus. This involves the study of problems regarding the electrical properties of materials used in the construction of electric equipment, the unification of guarantees to be given for certain types of equipment, agreement on ratings, testing methods, quality, safety, and dimensions to ensure interchangeability of machines, apparatus, and accessories.

International standardization projects are now being considered by 40 technical committees of the IEC. The standards produced by these technical committees are the tools of industry to help reduce costs, help produce more uniform quality, contribute to increased productivity, help to stabilize the market, and point direction to changes in market conditions. These can be helpful to all member countries, including the United States. The value the United States receives depends greatly on the extent of United States' participation.

The membership of the IEC is open to any self-governing country, and any country desiring to participate in the work of the Commission shall form a National Committee for its own country. The National Committees are constituted in the manner most appropriate to enable them to express their views on the questions under study. They are composed of representatives of the different technical and scientific bodies which deal on a national level with problems of standardization in the electrotechnical field. Close co-operation is maintained in every case between the IEC National Committee and the national standards body which, in the case of the United States, is the American Standards Association (ASA), a voluntary body of industry representatives.

For many years, the U. S. National Committee of the

R. C. Sogge, General Electric Company, Schenectady, N. Y., is president of the U. S. National Committee of the IEC.

IEC was located at AIEE Headquarters. Dr. Harold S. Osborne, who is now president of the IEC, was a secretary of the U. S. National Committee. The AIEE continued as a charter member of the U. S. National Committee when the responsibility for the U. S. National Committee was transferred to the Electrical Standards Committee of the American Standards Association. Some of the Standards Co-ordinating Committees of AIEE are the principal authorities for the United States' viewpoint on several basic projects now under active consideration in IEC on such subjects as the "General Principles for Rating and Temperature Limits and Co-ordination of Insulation." The AIEE serves as sponsor for the Development of Electrical Definitions and as the advisory group to the U. S. National Committee on corresponding international standardization. The AIEE is also sponsor for the ASA Sectional Committee on Lightning Arresters, *C62*, which is the advisory group to the U. S. National Committee on Technical Committee No. *37*. The AIEE Committee on Marine Transportation is the advisory group to the U. S. National Committee on Technical Committee No. *18*—Electrical Installations on Ships. The AIEE Standards Co-ordination Committee No. *8* is an important segment of the triple Joint AIEE–National Electrical Manufacturers Association–Edison Electric Institute Committee on Co-ordination of Insulation handled by Technical Committee No. *28*. The AIEE Standards Committee keeps informed on IEC matters through the appointment of the president of the U. S. National Committee as a liaison member to the AIEE Electrical Standards Committee.

In 1926, the Annual Meeting of the IEC was held in New York, N. Y. In addition to the technical committee meetings and local events, a highlight of the affair was a train trip as far west as Chicago, Ill., returning through Detroit, Mich., Niagara Falls, N. Y., and Boston, Mass. On this occasion, the delegates made numerous inspection trips to power installations and various industries where they were impressed with the wonderful development in the electrical industry.

GOLDEN ANNIVERSARY

Having in mind that a meeting of the IEC in the United States in 1954 could be a special event in the annals of United States standardization work, the U. S. National Committee authorized its representative attending the 1949 meeting in Stresa, Italy, to extend an invitation to the IEC to hold its 1954 meeting in the United States, which was accepted. A special committee investigated the best location, keeping in mind that it should be conveniently located, provide desirable living accommodations for visiting delegates who would have limited dollar exchange, and have plenty of meeting rooms for the numerous technical sessions of the technical committees. An ideal location was found at the University of Pennsylvania. The U. S. National Committee is indeed grateful to the University of Pennsylvania for making its facilities available.

Early in 1953, the U. S. National Committee organized a General Committee, under the chairmanship of Philip H. Chase, to make plans and a budget of expense for such a meeting. These plans and the budget were presented at

H. S. Osborne (right, standing), IEC president, congratulates R. C. Sogge on plans for the 50th Anniversary Meeting. Seated (left to right): Dr. C. C. Chambers, University of Pennsylvania; L. R. Barnhorst, Bell Telephone Company of Pennsylvania; L. D. Day, Jr., University of Pennsylvania; V. M. Graham, Radio-Electronics-Television Manufacturers Association; Dr. F. B. Silsbee, National Bureau of Standards; J. W. McNair, American Standards Association; Mrs. Jean Murphy, Jubilee Headquarters; P. H. Chase, Philadelphia Electric Company and chairman of the Jubilee General Committee; Orville Haas, General Electric Company; W. L. Healy, General Electric Company; Dr. S. R. Warren, Jr., University of Pennsylvania; C. T. Pearce, Westinghouse Electric Corporation

a future meeting, and Mr. Chase was authorized to proceed. Also, Walker L. Cisler was chosen as chairman of the Finance Committee.

Registration for the meeting begins August 31 in the Reception and Registration Center at Houston Hall. The technical committee meetings are scheduled from September 1 to September 16, and many such meetings will be held concurrently. Subjects to be discussed include:

Nomenclature
Rotating Machinery
Graphical Symbols
Hydraulic Turbines
Steam Turbines
Aluminum
Standard Voltages, Currents, and Frequencies
Electric Traction Equipment
Insulating Oils
Radio
Measuring Instruments
Power Transformers
Insulating Materials
Terminal Markings
Switchgear
Electric Ship Installations
Internal Combustion Engines
Electric Cables
Storage Batteries
Power Converting Equipment
Wiring Devices
Electrical and Magnetic Units
Letter Symbols
Electric Welding
Co-ordination of Insulation
Acoustics
Extra-High Voltages
Flameproof Enclosures
Fuses
Power Capacitors
Lamps and Holders
Dry Batteries
Sphere Gap Tests
Lightning Arresters
Instrument Transformers
Electronic Tubes

A number of plant visits are scheduled in the vicinity of Philadelphia to give the delegates an opportunity to see standardization at work in industry.

September 2 has been selected as the day for the welcoming reception in the University Museum. On that occasion, the delegates will be welcomed by representatives of the university, the city of Philadelphia, and the electrical industry.

On September 9, the Jubilee Day program will be held. Dr. Harold S. Osborne, president of the IEC, has organized a special program commemorating 50 years of progress in international electrotechnical standardization. Distinguished speakers from four countries will give addresses on subjects important to the electrical industry: M. Pierre Ailleret (France), Power; Dr. Haaken Sterky (Sweden), Communications; Lord Waverly (United Kingdom), Foreign Trade and General; Dr. L. A. DuBridge (California Institute of Technology), Science.

On the evening of Jubilee Day, the U. S. National Committee will be host at a banquet being given to the foreign delegates at which Mr. Cisler will be toastmaster. A. C. Monteith, president of the AIEE, will discuss the AIEE's interest and participation in the international standards work, and D. G. Mitchell, Sylvania Electric Products, Inc., has been invited to give the principal address.

On September 12 and 13, the committee has arranged a special trip for the foreign delegates to visit Washington D. C., and interesting places in the vicinity. Sunday will be devoted to sight-seeing. On Monday, the delegates will inspect the Bureau of Standards. A special Washington Committee, under the chairmanship of Dr. A. V. Astin, director of the Bureau of Standards, has arranged a meeting with Government and industry representatives at a luncheon in the Hotel Statler. Harold Stassen will be the principal speaker.

The technical committee work will be practically completed on September 15, and at 5:00 p.m. a Farewell Cocktail Party will be given the delegates.

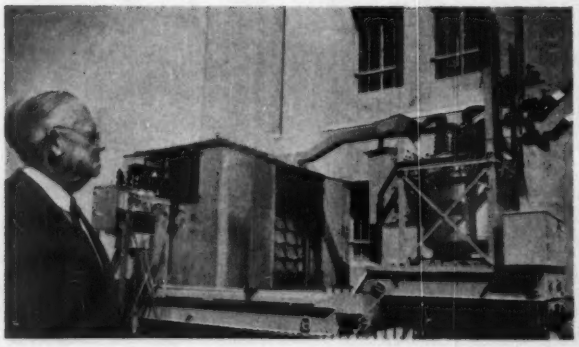
On September 15, the Committee of Action meets to receive reports on the technical committees' progress and to consider recommendations for IEC standards.

On Thursday, September 16, the IEC Council will hold a special meeting to take care of administrative matters which come before it; and with that meeting, the 1954 Golden Jubilee Meeting of the International Electrotechnical Commission comes to a close.

After the meeting, many of the delegates will take the opportunity to make business visits to industry, laboratories, and educational institutions. It is hoped that AIEE members will help to make their visit to the United States a pleasant one.

For further information write to IEC Golden Jubilee, Houston Hall, University of Pennsylvania, 3417 Spruce Street, Philadelphia 4, Pa.

Mobile Test Stand Added to High-Potential Equipment



A mobile test stand, capable of delivering 200,000 amperes and believed to be the most powerful of its kind, has been added to the high-potential equipment installed at the California Institute of Technology. Designed by Dr. Royal W. Sorensen (shown at left with the trailer-mounted test stand), the performance of the equipment has been proved in determinations of the carrying capacity of high-current electric contacts up to about 92,000 amperes. The test stand is mounted on a trailer so it can be moved to power system with large substations to reach its full capacity of 200,000 amperes. The equipment was designed for the study of protective devices, such as switches, disconnects, and circuit breakers, that will be subjected to large fault currents. Features of the stand include an 8-ton transformer inside weatherproof aluminum housing at left, and 2-ton primary circuit breaker at right

Fast-Response Magnetic Amplifiers

G. E. HUGHES
ASSOCIATE MEMBER AIEE

H. A. MILLER
ASSOCIATE MEMBER AIEE

A MAGNETIC AMPLIFIER having a characteristic of "single-cycle" response was introduced by Ramey in which the load and control circuits are not mutually coupled in the usual sense. Instead, they operate on the magnetic state of the core on a time-sharing basis. With a rectangular flux-current loop core material, ideal rectifiers, sine-wave voltage sources, $R_{cT}=0$, and with the input signal to the amplifier of Fig. 1 a half-wave rectified sine wave, the gain in terms of average input and output voltages is just the turns ratio. Thus, by decreasing the control turns, the gain is increased. The inclusion of R_{cT} in the circuit results in a constant voltage drop $I_m R_{cT}$ during reset and hence a decreased resetting action. Further, since the magnetizing current which causes this drop increases as the control turns are reduced, there is an optimum number of control turns.

The gain may be expressed as

$$G=\frac{N_G}{N_c}\sqrt{1-\frac{H_c L_\varphi R_{cT}}{kN_c^2(1-E_a/E_{ac})}} \tag{1}$$

where the radical is a correction factor accounting for the control circuit resistance. This is shown in Fig. 1 as the zero signal gain per load turn. H_c is the coercive force, L_φ, the magnetic path length, and k is the peak voltage per turn constant of the core. The experimental curve shown for a Deltamax core differs from the theoretical curve since the assumptions regarding the core and rectifier characteristics are imperfectly met. The required number of control turns for maximum gain is

$$(N_c)_{\text{max gain}}=3^{1/4}\sqrt{\frac{H_c L_\varphi R_{cT}}{k}} \tag{2}$$

and the resulting gain is

$$\left[\frac{G}{N_G}\right]_{\text{max gain}}=3^{-3/4}\sqrt{\frac{2k}{H_c L_\varphi}}\times\sqrt{\frac{1}{R_{cT}}} \tag{3}$$

It appears that an unlimited gain may be achieved by increasing N_G, but because the gain is also a function of the load winding resistance and only a limited area is available for the winding, an optimum figure for N_G also may be determined. If a winding area of KA_w square inches is available, the maximum gain by load circuit design then occurs when

$$N_G=\sqrt{\frac{R_L K A_w}{\rho L_t}}\,2\times10^4 \tag{4}$$

The mean length of turn is designated L_t. The over-all maximum realizable voltage gain is then

$$G_{\max}=3^{-3/4}\times10^3\sqrt{\frac{2k}{H_c L_\varphi}\times\frac{KA_w}{\rho L_t}\times\frac{R_L}{R_{cT}}} \tag{5}$$

When the magnetic amplifier is to deliver appreciable power, the current-carrying capacity of the wire in the load winding becomes a limiting factor. This imposes an upper limit on the power output shown by the hyperbolas in Fig. 2 and requires that the load conduction angle be less than π radians. In this situation, the allowable power output may be increased considerably by reducing N_G and increasing the wire cross section to fill the window area. In one example, the parameter of Fig. 2 is 3.91 and the power output is increased from 0.356 to 0.78 of the maximum possible power output of 47.7 watts while the voltage gain decreases to 0.88 of the maximum of 60.2.

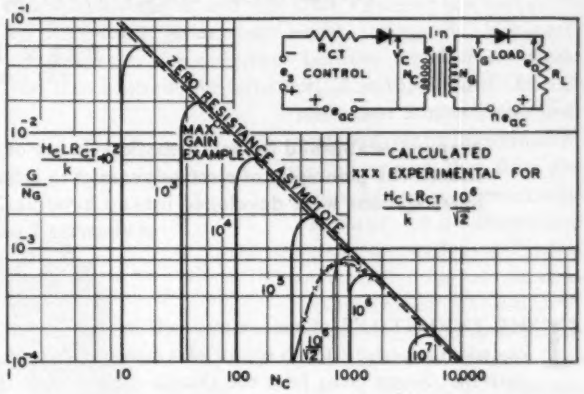


Fig. 1. Gain versus control turns with $R_{cT}\frac{(H_c L_\varphi)}{k}$ as a parameter

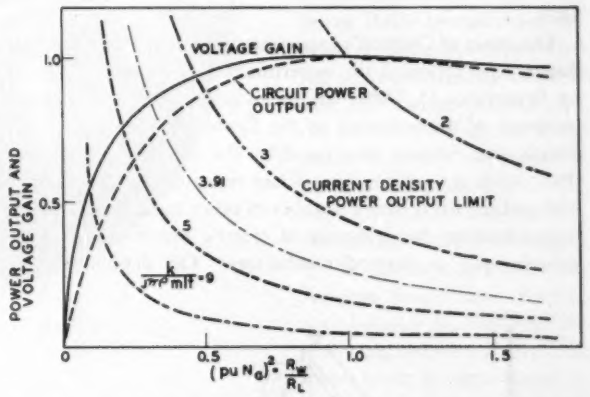


Fig. 2. Theoretical voltage gain and power output expressed in per-unit values

Digest of paper 54-159, "Fast-Response Magnetic Amplifiers," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954. Published in AIEE *Communication and Electronics*, March 1954, pp. 69–75.

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TEN FOUNDING FATHERS OF THE ELECTRICAL SCIENCE

V. ANDRE MARIE AMPERE

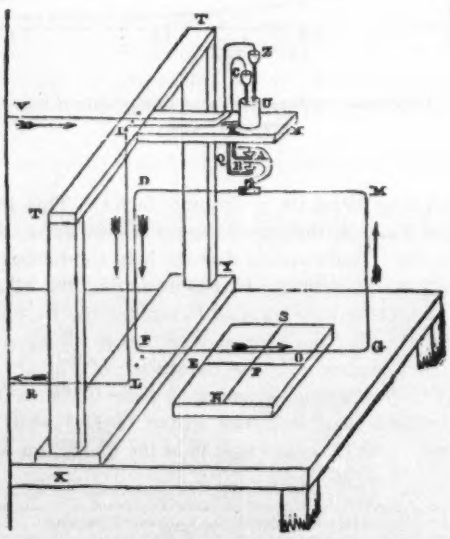
and the beginning of electrodynamics

BERN DIBNER
FELLOW AIEE

Ampere established the mathematical theory of electricity and by a series of experiments demonstrated the principles of electrodynamics in adjacent current-carrying conductors. His electrical investigations were developed into an hypothesis that magnetism was essentially a phenomenon of electrified particles of matter.

THE INVENTION of the voltaic cell in 1800 gave electrical experimenters a source of a constant flow of current. Seven years later the Danish experimenter, H. C. Oersted, announced that he would attempt to establish a relationship between an electric flow of current and a magnetic needle. Yet it required 13 years more for this brilliant discovery to be made and announced by him in 1820.

The news of Oersted's experiment reached Paris through Arago who repeated the experiment at a meeting in Paris on September 11, 1820. In the audience was Ampere, then professor of mathematics of the École Polytechnique. So deeply was Ampere impressed by the Oersted experiment that within a week he himself had repeated the experiment and elaborated it into a number of other basic relationships demonstrating the behavior of electric current flowing in straight and in formed conductors. On September 18, Ampere presented before the Academy his observations establishing the science he designated as "electrodynamics." In a paper entitled "Experiments on the New Electrodynamical Phenomena," published in 1822, Ampere stated, "I have determined to use the word *electrodynamic* in order to unite under a common name all these phenomena, and particularly to designate those which I have observed between two voltaic conductors." He then distinguished electromotive action as being of two kinds, which he designated as those of *electric tension* and those of *electric current*. The former exists, he said, when two bodies are separated from each other by a nonconductor, such as the tension between the poles of a voltaic cell before they are connected by a conductor. In the case of flowing current the second exists where elements form part of a circuit of conducting bodies. Thus, pointed out Ampere, two bodies similarly charged electrostatically repel each other, whereas two conductors carrying currents in the same direction attract one another. Ampere was convinced that magnetism was an electrical phenomenon and that the direction of motion of a magnetic pole, when adjacent to a current-carrying wire, was neither towards nor away from the wire "but in a line at right angles to a plane passing through the pole and the conductor." The force of this attraction or repulsion, he proved, was directly proportional to the strength of the currents, and inversely proportional to the square of the distance between them, a relationship which prompted Clerk Maxwell to write that these achievements had "leaped full grown and fully armed from the brain of the Newton of Electricity."



From Ampère, "Exposé des Nouvelles Decouvertes sur L'Electricité", 1822.

The relationships between parallel wires then were expanded to include conductors bent into the forms of coils and helixes, some fixed and some free to move on pivots, and to show that such a spiral coil (solenoid) when carrying a current behaved exactly like a magnet. Such a coil, if delicately balanced and free to swing, should swing and adjust itself to the earth's magnetic field; this he arranged and demonstrated, thereby causing a current-carrying wire to behave like a magnetic compass needle. He then could explain the earth's magnetism by terrestrial electric cur-

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rents that circulated in the earth from east to west. Such currents, he speculated, might be caused by chemical action between the heterogeneous materials in contact within the globe, as Volta had demonstrated with different metals in contact.

Ampere formulated these observations into some general rules: (1) Two electric currents attract when they flow parallel to one another in the same direction and repel when they flow parallel to one another in the opposite direction. (2) It follows that when metallic conductors along which currents flow cannot turn into the parallel plane, each conductor tends to move the other conductor into a position parallel to it and in the same direction. (3) The attractions and repulsions are absolutely different from ordinary (electrostatic) electricity. (4) All the phenomena disclosed by Oersted regarding the relationship of the flow of an electric current and a magnet are covered by the law of attraction for two electric currents. This law follows from the deduction that a magnet is a product of electric currents produced by the action of the particles of iron on one another.

Ampere recommended two experimental approaches to determining the mutual action of currents. The first consisted in actually measuring the forces at varying distances; the second consisted in balancing the effects produced by the two currents acting on a third body in keeping it in equilibrium. This second method (called the null method) is experimentally the more accurate. To apply the second method and determine if the forces were in true balance, Ampere arranged two coils on his apparatus and mounted them so that they were equally and oppositely affected by the earth's magnetism, forming, thereby an *astatic* pair of coils. With this and similarly original equipment he arrived at the following four observations:

(1) The effect of a current is reversed when the direction of the current is reversed. (2) The effect of a current flowing in a circuit twisted into small turns is the same as if the circuit were expanded. (3) The force exerted by a flowing current on an element of another circuit is at right angles to the line uniting them. (4) The force between two elements of circuits is unaffected when all linear dimensions are increased proportionately, the current strength remaining unaltered.

As one who had mastered the mathematics of his day at age 12, at 18 had read the main works of Lagrange, and later was a teacher of mathematics at Lyons and at Paris, Ampere had acquired habits of clear, exact thought which resolved ideas into quantitative elements. His electrical investigations therefore were developed into an hypothesis that magnetism was essentially a phenomenon of electrified particles of matter. It must be borne in mind that when Ampere was formulating his theories, there was still no conception of the idea of a difference of potential or that of electromotive force, and that Ohm's guiding law had yet to be determined, given to the world, and tested. Nor could Ampere show the difference between an electric current and the electromotive force that caused it to flow. He did state that a new instrument was available for detecting current flow and that from the nature of the new current to be measured this instrument should be called a "galvanometer." Just as an electrometer measured "ordinary" electricity, so the new galvanometer would measure the flow of electricity. Ampere intended his instruments to operate along the lines of Oersted's pivoted needle but, a few months later, J. S. Schweigger of Halle brought out the first true galvanometer consisting of a coil of many turns of wire and a magnet hung on a silk thread in the center of the coil. Ampere suggested a method of signaling at a distance by placing a galvanometer in a circuit of great length.

Andre Marie Ampere

The ideas propounded by Ampere found slow acceptance because his explanations of electric behavior showed the forces to act at right angles to the directions of flow of these forces and were therefore counter to Newton's ideas of forces acting in straight lines. However, later Ampere's explanations were endorsed by such authorities as Fourier and Laplace.

To Ampere the world of science owes a debt for his part in formulating the then little-understood electrical phenomena into a measurable and corroborative body of experiments and theory. His personal life was a disciplined and joyless one. His father was a victim of the excesses of the French Revolution, a tragedy that almost destroyed Ampere. His scientific interests were broad, and his published works included studies in mathematics, physics, chemistry, psychology, and natural history in addition to those in electricity. In his advanced years he developed a new classification of all the sciences and, by a process of subdivision, reached a total of 128 sciences and subsciences including one he called "cybernetics," another "technesthetics." His work and his name have become perpetuated by action of the International Congress of Electricians who designated the practical unit of current as the "ampere."

Magnetic Ferrites: New Materials for Modern Applications

V. E. LEGG
MEMBER AIEE

C. D. OWENS

Ferrites are serving very effectively in the vanguard of communication developments. Their basic properties and methods of application are discussed which show how they have begun to revolutionize the design and manufacture of inductors and transformers.

THE practical achievement of new ferromagnetic nonmetals, or ferrites, was announced at the end of World War II.[1,2] In the intervening years dozens of laboratories and manufacturing concerns around the world have exploited the study, development, and production of these new materials. As a result, the design engineer has available today a variety of ferrites representing an array of properties or combinations not previously available. These magnetic ceramics are taking their places rapidly as very important engineering resources, sometimes as supplements to, and sometimes as replacements for metal sheet, ribbon, or powder. It is the purpose of this article to survey, from the designer's point of view, the outstanding properties, and those applications of the available ferrites which have reached commercial use.

The development period in ferrites has coincided with the advances toward high frequencies due to FM radio, television, and microwave circuits. It has occurred during a time when emphasis has developed on increased stability and reliability of electric circuits, and in miniaturization of components for use in military and commercial applications. Many of the characteristics of ferrites have been found to be mutually accommodating to the requirements of the new trends in communications and have led to more or less obvious applications. Some circuit requirements have pointed to deficiencies and hence to needed new performance characteristics. It has been possible to alter the behavior satisfactorily in many cases by adjustments of composition or heat treatment of the material. Some of the unique properties of ferrites have led to the realization of entirely new microwave circuit elements, such as the gyrator.[3]

Ferrites are based upon the most ancient known magnetic material, magnetite, Fe_3O_4, which is strictly "ferrous ferrite." They are flintlike solid ceramic bodies produced by firing compacted mixtures of oxides of iron, and one or more oxides of nickel, zinc, manganese, magnesium, copper, or other metals. They are so hard after firing that abrasive grinding methods must be resorted to in machining them. They are characterized by high initial permeability. They have resistivities many orders of magnitude greater than those of metals, and may be classified as semiconductors.

Because of the extremely high resistivities of ferrites, the material can be used for apparatus cores in bulk form without undue losses, which otherwise would require lamination or subdivision of the material to provide eddy current control. Also, since the manufacturing processes are similar to those employed for ceramics, it is feasible to press, mold, or extrude the material into shape before firing. A shrinkage of 10 to 20 per cent in linear dimensions results during firing so that the unfired part has to be made correspondingly oversize. With moderate care, the surfaces of ferrite parts can be ground or lapped so flat and smooth that mating surfaces may have an effective air gap of the order of only 0.0001 inch. As a result, ferrite parts can be assembled within windings to achieve over-all magnetic performance very nearly equivalent to that which would be realized in a solid closed circuit core. The resulting cores such as illustrated in Fig. 1 can be handled and assembled with much greater convenience than similar cores of laminated metals. Also, much higher permeabilities can be obtained than for molded powdered iron cores. When a finite air gap is required to obtain optimum Q and stability, as in precision inductors, advantage can be taken of the air gap to build into the core structure provision for inductance adjustment.[4] When the high-permeability ferrite is made to enclose the windings completely, as in cup or pot cores, substantial magnetic and electrostatic shielding is realized.

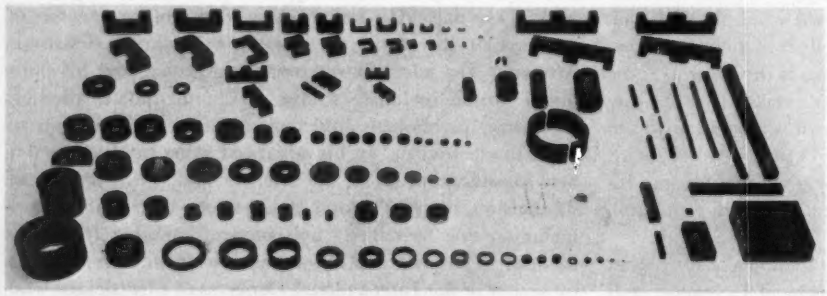

Fig. 1. Assorted ferrite core shapes

Revised text of a conference paper presented at the AIEE Winter General Meeting, New York, N. Y., January 18–22, 1954, and recommended for publication by the AIEE Subcommittee on Magnetics of the Committee on Basic Sciences.

V. E. Legg and **C. D. Owens** are with the Bell Telephone Laboratories, Murray Hill, N. J.

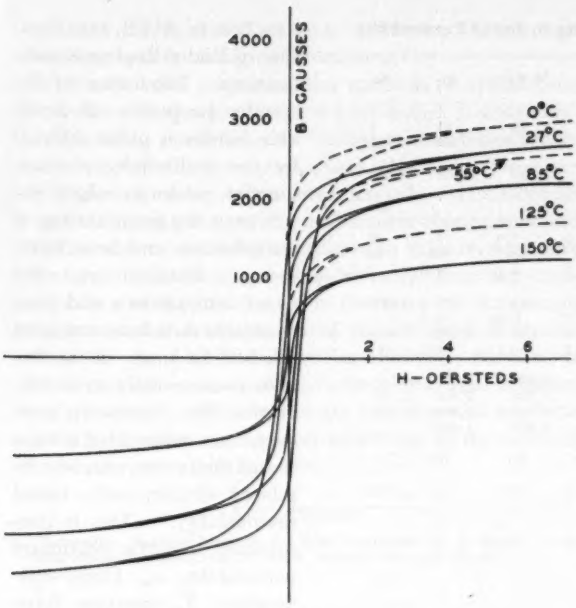

Fig. 2. Hysteresis loops for Ni Zn ferrite

Ferrites have high values of dielectric constant. In some samples, apparent dielectric constants over 100,000 are measured at voice frequencies. The dielectric constant decreases with increasing frequency, approaching a value of near 10 at microwave frequencies. The dielectric Q is usually less than unity. Due to interaction of dielectric properties with normal eddy current flow ferrites exhibit resonance-type behaviors of permeability and core loss as frequency and dimensions are varied. Such phenomena may affect the selection of ferrite type and core dimensions for r-f applications.

The flux densities at which ferrites saturate are low compared to those of most metallic magnetic materials. The saturation flux density decreases rapidly with increase in temperature in the vicinity of the Curie temperature. The applications of ferrites are limited, therefore, to the use of small flux changes, except where core cross section is made large enough to compensate for intrinsically low saturation values. An example of the latter is in television flyback transformers and deflection yokes, which use a major part of the tonnage of ferrite manufacture. In this application the magnetic requirements are primarily high permeability at the sweep frequency, 15 kc, low loss at flyback frequency, up to 100 kc, and stability at temperatures encountered in television sets. The advent of the ferrite core for television transformers after 1949 resulted in a more efficient transformer design of smaller volume and weight than was previously possible with powdered iron cores.

Typical hysteresis loops for nickel zinc ferrite with an initial permeability of approximately 800 are shown for several temperatures in Fig. 2. The effect of temperature on saturation induction will be noted. It is obvious that the location of ferrite-cored apparatus should be either remote from heat suorces or where cooling ventilation is most effective. The ferrite compositions in use for television transformers represent practical compromises between the conflicting effects of raising Curie temperature and raising permeability.

Extruded rods of nickel-zinc-type ferrite several inches long are being used extensively as antenna coil cores for radio receiving sets. High Q and good stability are desirable characteristics and considerable development work has been in progress to improve these properties. Shorter lengths of rods of nickel zinc ferrite are used advantageously for adjusting solenoidal inductors in radio and television circuits. Long rods of manganese zinc ferrite have been stacked to build a core for the oscillator tank inductor for the Brookhaven Cosmotron.[5]

Manganese zinc ferrites have found application for cores of inductors for filter circuits, requiring precision adjustment of inductance, coupled with very high Q's. A permeability of approximately 1,500 with a μQ of 150,000 at 100 kc has been developed for this application.[6] A filter coil is illustrated in Fig. 3, which has found large application in carrier telephone circuits.

Another application of particular value is the use of small cup cores of various sizes and permeabilities for inductors and transformers. A small transformer for use in a transistor circuit is shown in Fig. 4 alongside a television flyback transformer.

An application of growing interest is that of small cores of square loop ferrite for computer circuits.[7,8] Square loop

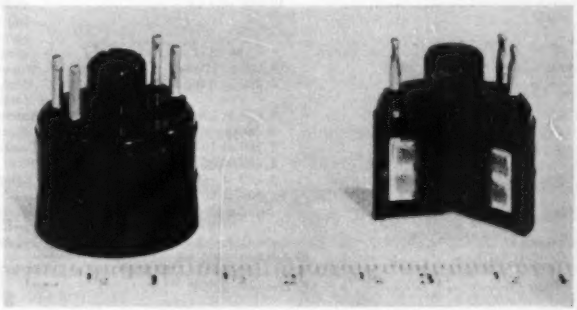

Fig. 3. Adjustable ferrite inductor for type O carrier filters

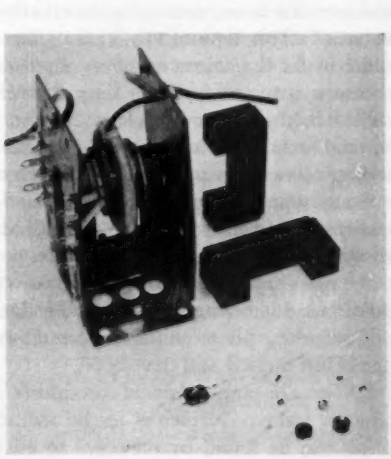

Fig. 4. Pulse transformers for transistor circuits (foreground); horizontal television deflection transformer (background)

Table I. Some Typical Characteristics of Ferrites Arranged According to Initial Permeability

Composition	Ni Zn	Mn Zn	Ni Zn‡	Ni Zn‡	Ni Zn‡	Ni Zn‡	Ni	Fe
Initial perm. μ_0	4,000	1,500	500	200	100	50	15	5
Max. perm. μ_m	12,000	2,500		1,000	200		100	25
Saturation flux density B_m	2,200	3,000	2,900	4,200	2,000	3,550	2,500	6,150
Residual flux density B_r	500	1,200	1,500	2,700	900			800
Coercive force H_c	.04	0.1	0.4	0.5	4.0	7.0	14	40
Resistivity ρ (ohm-cm)		50	10^5	10^2	10^3	10^4	10^6	10
Specific gravity	5.1	4.9	4.8	4.6	4.2	4.1	4.0	5.2
Curie temp. °C	70	110	125	270	350	465	585	578
μ_0-temp. Coeff; %/°C	0.3	0.25	0.5	0.3	0.2	0.05	0.1	
Hysteresis Coeff§ $a \times 10^{+6}$	3.6	1.6	6.0	6.5	7.5	50	50	
Eddy Current Coeff§ $e \times 10^{+6}$	2.4	0.3	0.4	0.2	0.2	0.1	0.1	
μQ‖ at 10 kc	50,000	400,000			10,000	7,500	2,800	
μQ at 100 kc	17,500	150,000	28,000	15,000	9,000	7,500	2,800	
μQ at 1,000 kc	1,750	9,000	5,000	12,000	7,500	7,200	2,800	
μQ at 10,000 kc	10	50	300	250	200	5,000	1,600	
Diel. const. (100 kc)	10^3	10^5	10^3	10^3	10^3	10^3	10^3	
Saturation magnetostriction $\times 10^{+6}$		−0.5	−4.	−7.5	−15.5	−18.5	−22	+30

‡ Other elements such as Cu, Mg, and Mn are often added.
§ See reference 13 for definitions and method of evaluating a and e.
‖ See reference 6 for discussion of μQ as a figure of merit.

Table II. Summary of Ferrite Applications

Most Useful Frequency Range	Initial Permeability	Typical μQ Values	Type of Ferrite	Typical Applications
Below 100 kc	3,000–6,000	15,000 at 100 kc	Ni-Zn	Miniature coils and transformers, pulse transformers
10 kc–1 mc	1,000–2,500	150,000 at 100 kc 10,000 at 1 mc	Mn-Zn	Transformers and high-quality inductors for telephone use, recording heads
100 kc–2 mc	400–1,200	50,000 at 100 kc 12,000 at 1 mc	Ni-Zn¶	Television flyback transformers, television deflection yokes, suppression coils, recording heads, magnetic amplifiers, saturable reactors, tunable inductors, general-purpose inductors
500 kc–5 mc	200	15,000 at 100 kc 4,000 at 3 mc	Ni-Zn¶	Antenna rods, tuning plugs, saturable reactors, magnetic amplifiers, r-f power transformers
1 mc–15 mc	100	9,000 at 100 kc 2,000 at 10 mc	Ni-Zn¶	Antenna rods, tuning plugs, pot cores, resonant circuits
5 mc–25 mc	50	7,500 at 100 kc 2,000 at 20 mc	Ni-Zn¶	Tuning plugs, pot cores
>25 mc	15	3,000 at 100 kc 500 at 50 mc	Ni	Tuning plugs, high-frequency inductors
Pulse	50	Square loop	Mg-Mn	Memory arrays, magnetic amplifiers, magnetic switches
Microwave	Faraday rotation, low losses at 4,000–11,000 mc		Mg-Mn	Gyrator, phase shifter, switches

¶ Other elements such as Cu, Mn, and Mg are often added.

properties have been obtained through special composition and manufacturing processes, as well as by applying external stresses.[9] This type of application may easily grow to require by far the largest numbers of pieces of ferrite parts for memory arrays, but due to the extremely small size of the cores it might not require a large tonnage of ferrite material. Special techniques have been developed for producing and testing cores down to less than 0.1-inch diameter.

Some types of ferrite have been found to be more or less transparent to microwaves, and to produce large Faraday rotation. This opens up entirely new possibilities in microwave circuitry. Isolators, to suppress reflections in waveguides used in communication and radar circuits, and various switches, phase shifters, attenuators, and modulators are being studied and developed.

There are a number of producers of ferrites in this country today. Names of ferrite manufacturers and suppliers can be found by reference to advertising and directory lists in AIEE and Institute of Radio Engineers publications. Tabulation of the specific properties of available ferrites is made difficult by the multiplicity of commercial products, which result from the great variety of compositions and heat treatments. Furthermore, the exact compositions and heat treatment data have not been released for many of the ferrites commercially available. It has been observed, however, that many characteristics of the ferrites can be correlated directly with initial permeability. This is particularly true for maximum permeability μ_m, Curie temperature T_c, coercive force H_c, and maximum useful frequency* f_m but less so for core losses and temperature coefficients, as will be observed from Table I. The data here reported are based upon measurements by the authors as well as published information and are believed to represent expected normal characteristics of various commercial types of material.† They do not represent specification requirements of the manufacturers. It should be kept in mind that permeability and core loss are likely to fluctuate over a range as wide as two to one on cores from a single type of material, and that special treatments may sometimes be used to favor certain characteristics.

Table I lists representative values for eight different permeability groups of ferrites and Table II lists the usual frequency ranges and typical applications. In using these tables, it should be remembered that permeability and core loss data apply primarily below frequencies indicated in Table II. At successively higher frequencies complica-

† Ferrite manufacturers whose products or data have been examined by the authors: Allen-Bradley Company, Milwaukee, Wis.; Henry L. Crowley and Company, West Orange, N. J. (Croloy); Ferroxcube Corporation of America, Saugerties, N. Y. (Ferroxcube); General Ceramics and Steatite Corporation, Keasby, N. J. (Ferramic); General Electric Company, Schenectady, N. Y.; National Moldite Company, Hillside, N. J.; Radio Corporation of America, Camden, N. J.; Stackpole Carbon Company, St. Marys, Pa. (Ceramag); D. M. Steward Manufacturing Company, Chattanooga, Tenn. (Lavite Ferrite); Western Electric Company, New York, N. Y.

Note: Western Electric manufactures ferrites primarily for use in communication equipment of its own manufacture. Certain other suppliers also may not manufacture for general sale.

* The maximum useful frequency f_m is defined as that for which Q_m has decreased from its maximum to a value of 10. See reference 10.

tions arise due to core dimension resonance, domain wall relaxation, and ferromagnetic resonance.[11]

With such basic properties and methods of application, the advent of ferrites has initiated a revolution in design and manufacturing possibilities for inductors and transformers used in carrier telephone, radio, and television. These are just beginning to be evident commercially. The freedom to assemble high-permeability ferrite cores about prewound coils has assisted the design engineer to achieve miniature inductors and transformers. This is timely when such components are in demand for use in transistor circuitry, computers, and the development of minute-sized electronic automata. At higher frequencies, Faraday rotation of electromagnetic waves opens up entirely new fields in microwave circuitry.[12] Thus ferrites are welcome new magnetic materials which are serving very effectively on the forefront of communication developments.

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Practical Use of Tracer Controls

G. L. ROGERS J. L. DUTCHER

For optimum results a tracer control system must be designed into a machine tool—it cannot be regarded as an attachment. It must have numerous machine features added or changed to allow the tracer to perform at its best and to make the machine's operation practical from the operator's viewpoint.

A TRACER - controlled machine is different from the usual machine tool in two basic respects. First, it is operated in a different manner and therefore various operating features are required which are not needed on standard machines. Provisions for efficient setup of tracing head, template, and work must be made so that the time saved in machining is not lost during setup operations.

Second, a different concept of machine mechanical design is required. Machine deficiencies such as vibration, stickiness, and backlash produce different effects when a machine is tracer-controlled than they do when it is under the control of an operator. While the tracer can compensate for these deficiencies under many conditions, it may tend to exaggerate their effects under others. Since the tracer-controlled machine is asked to cut all shapes, including many that would not be attempted otherwise, the correct set of operating conditions to make any of these faults evident will be attained sooner or later.

This article, based upon experience in applying tracer equipment to many different types of machine tools, attempts to outline this necessary co-ordination between machine and tracer design. However, because of the rapidly expanding use of this type of equipment, it must be recognized that what is known today is only a small part of all there is to know. Each time a tracer is put to some new use, a new problem will arise and be solved thus adding to the store of information.

There are a number of basic types of tracer systems. Single-dimension tracers normally used on lathes are the most common. Two-dimension tracers are used on milling machines for profiling work and also on vertical boring mills (Fig. 1). Selective 2-dimension tracers, which are used for die sinking or similar machining operations, provide tracing in any one of the three principal planes of the machine with the selection of the operating plane being made by simple switching methods. Simultaneous 3-dimension tracing may be accomplished by combining a 2-dimension and a single-dimension tracer and using either two tracing heads and two templates or a single combined

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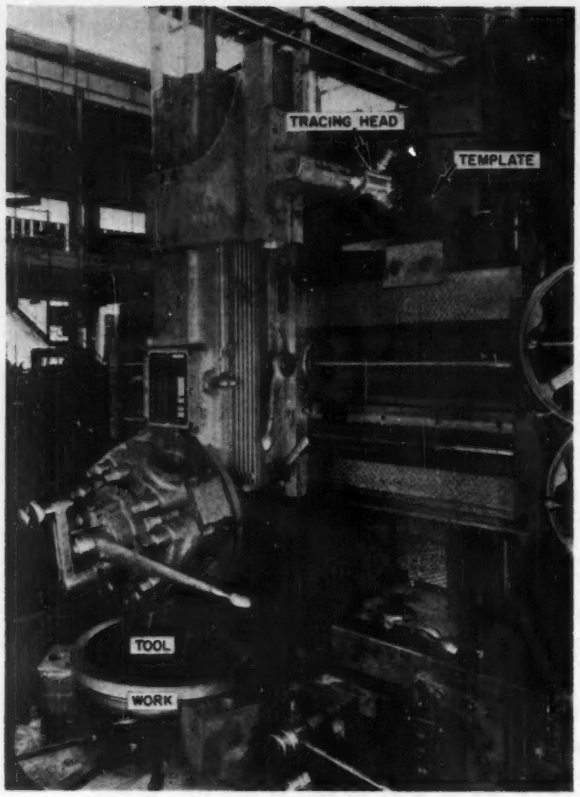


Fig. 1. Vertical boring mill with 2-dimension tracer control

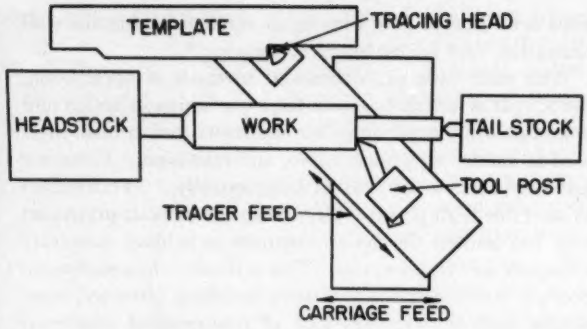


Fig. 2. Arrangement of a single-dimension tracer system applied to a lathe

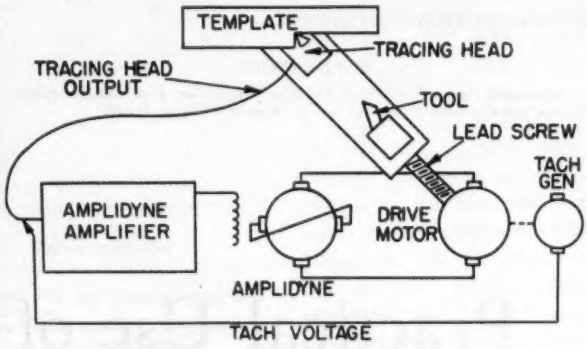


Fig. 3. An electric single-dimension tracer system

tracing head utilizing one 3-dimensional template.

In order to understand how various factors affect tracer performance it is necessary to have a basic understanding of how tracer systems operate. For this reason two electric tracer systems first will be discussed briefly. While these are only two of many different tracers, most systems are basically similar and therefore are affected in much the same manner by most operating conditions.

All tracers, whether they be hydraulic, pneumatic, mechanical, or electric, are made up of essentially the same parts in one form or another. Each tracer includes a sensing element which feels the surface of the template and provides a form of intelligence to the tracer. It includes amplifying elements which amplify and generally modify this intelligence to make it useful in controlling drive elements which power the machine. Also a real part of the tracer system is the mechanical gearing or linkages which transmit power from the drive elements to the linear motion of the machine feeds.

SINGLE-DIMENSION TRACER

SINGLE-DIMENSION tracers are used most commonly on lathes but also find use on boring mills and some milling machines. The position of only a single machine motion is controlled by the tracer while a second feed is driven at a constant rate by some other means.

Fig. 2 shows such a system applied to a lathe. It will be noted that in this case the tracer-controlled feed is at 45° to the machine axis to aid in turning shoulders. The carriage feed is driven at a constant rate, or in some cases is slowed down, when a sharp shoulder is reached but is controlled independently. The unique feature of single-dimension system is that there is a position error which is proportional to the rate of motion of the tracer-controlled feed. This error can be made extremely small, but it is always present.

The General Electric single-dimension tracer consists of a tracing head, an electronic control panel, and a power unit which in the case discussed here, consists of an amplidyne generator and a d-c motor which powers the machine feed. This equipment is arranged essentially as shown in Fig. 3.

The object of the tracer is to hold the stylus of the tracing head in contact with the template with as near a constant deflection as possible. Since the tool and tracing head are mounted on the same slide, the tool then will follow the contour of the template.

The amplidyne amplifier, amplidyne, motor, and tachometer generator make up a speed-regulated feed drive. The amplidyne is similar to a d-c generator except that its fields require sufficiently low excitation to allow them to be supplied by the vacuum tubes of the amplifier. The amplidyne supplies adjustable direct voltage to the motor armature and in this adjusts its speed. The tachometer supplies a direct voltage proportional to motor speed which is compared with the output voltage of the tracing head. The amplifier uses any small difference to cause these two voltages to become more nearly equal. In this way the

speed of the feed motor remains directly proportional to the output of the tracing head. Since the tracing head output is proportional to the amount that it is deflected from a neutral position, the tracer slide will move backward or forward at speeds proportional to the amount the stylus is deflected from this neutral position.

Thus, when the tracing head is away from the template it tends to run in toward it until the stylus makes contact and is deflected to its mid-position. At this point the output voltage from the head and consequently the motor speed are zero. When the independent feed is started, the tracing head moves along the template and any rise or fall in the template surface tends to change the stylus deflection. This causes the feed to run in the direction of the deflection. Consequently, the template is traced with the stylus deflection remaining constant plus or minus a very small amount which is proportional to the speed at which the tracer-controlled feed must run.

2-DIMENSION TRACER

Although several parts of the 2-dimension or profiling tracer have a considerable resemblance to corresponding parts in the single-dimension system, the basic principle of operation is different entirely. In this case, two machine feeds at right angles to each other are controlled and the deflection of the tracing head stylus literally steers the tracer around the template at a constant speed. This 2-dimension system has been used on boring mills and essentially all types of milling machines.

Fig. 4 shows the general arrangement of the tracing head, electronic control, amplidynes, motors, and machine gearing. It will be noted that the two feed drives are similar to the one described in connection with the single-dimension tracer. The speeds of the motors are again proportional to the direct voltages which are the inputs to these drives.

The tracing head produces an electric signal which indicates at what angle and by what amount the tracing head stylus is deflected. This signal is modified by the electronic control to provide two direct voltages which indicate by their polarity and magnitude, the direction and speed at which the two feed drives must run to cause the tracing head stylus to move tangential to the template at a constant speed.

The tracing head stylus, being free to deflect in any direction, is deflected at essentially right angles to the template. This produces an a-c output voltage the phase of which indicates the direction of deflection and consequently the direction that the feeds must run in order to move tangent to the template. This gives the basic direction to the feed motors and the tracer would operate on this signal alone if everything were perfect. However, numerous factors do exist which quickly would cause the stylus to run off on one side or the other of the desired path, and because of that, deviations from the desired path must be recognized and used to correct the basic direction signal. This is done through what amounts to a steering action.

The magnitude of the tracing head output voltage is proportional to the amount of deflection; therefore any deviation from the desired path produces a change in the magnitude of this signal which in turn institutes a corrective steering action to guide the tracer back to the correct path. At the normal or operating deflection, the phase signal theoretically causes the tracer to run tangential to the template surface. If it tends to run toward or away from the template, the resulting increase or decrease in the output signal causes a phase shift which steers the tracing head back to the desired path.

Since the tracing head is sensitive to deflections in all directions and the amplidyne feed drives are completely reversing without the use of relays or contactors, this tracer will profile around a template through 360° without attention from the operator. The rate of travel with respect to the surface of the template is constant regardless of direction and because of its steering action it is theoretically a zero-error system. Of course, small errors do occur but they are not basic to the system; they are due to deficiencies in the electric equipment or the machine tool.

These errors are also present in the single-dimension and other systems. They may be broken down into three types: (1). Resolution errors due to very small imperfections in the electric or mechanical system for which the tracer must compensate. This compensation requires a change in stylus deflection and consequently results in an error. (2). Errors on corners or sharp curves due to the inability of the feed motor to change speed instantly. (3). Errors caused by machine imperfections which are outside the tracer control loop and therefore cannot be compensated for or which upset the tracer system and cause transient errors.

Everything possible is done to the electric system to compensate for both its own deficiencies and those of the machine. However, since compensation never can be complete, it is essential that machine deficiencies be eliminated or reduced to the absolute minimum. These deficiencies are

1. Backlash in the feed drive.
2. Windup in the various parts of the feed drive system.
3. Stickiness of the machine ways.
4. Vibration.
5. Deflection of the machine members.
6. Misalignment of the tracing head.

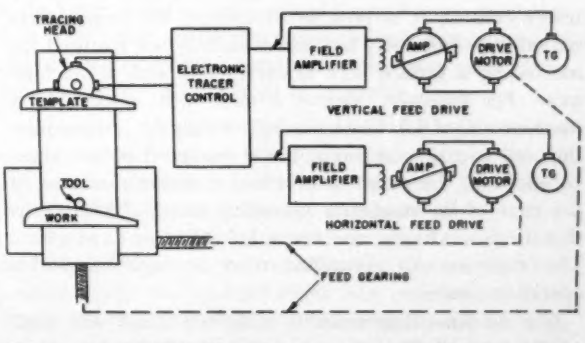


Fig. 4. An electric 2-dimension tracer system which has control of two machine feeds allowing complete profiling operations

EFFECTS OF MACHINE DEFICIENCIES

Backlash and Windup. Backlash as used here may be defined as the total free play between the motion of the machine slide and the rotation of the feed motor shaft in terms of linear movement of the slide. It includes end-play of the lead screw, slop in the nut, and backlash in the gears. Windup, the amount of additional deflection between the time the backlash is taken up and when the slide actually starts to move, may be defined also in terms of equivalent linear movement of the slide. For purposes of discussion, backlash and windup will be lumped together as a single characteristic since their effects are roughly similar although not identical. These two will be spoken of simply as backlash except in discussing the effects of stickiness.

Backlash is most evident at the point on a contour where one of the machine feeds must reverse or where the cut is directly in line with a machine axis. As a tracer approaches a point on a contour where a feed must reverse, the feed motor slows down and stops. Then, it starts turning in the opposite direction but the slide does not move because of the backlash. By the time the backlash has been taken up, an error has resulted and, due to the excess speed of the motor at this point which results from the error, an overcorrection is apt to result. Under the right conditions on cuts along a machine axis, a sustained oscillation or hunt can develop with the tool stepping back and forth from one side of the desired path to the other.

Since the backlash is within the control loop of the tracer, the error which results is by no means equal to the amount of backlash. Experience has shown that on machines using feed speeds of the order of 1 or 2 inches per minute, there is only a very small error at the point where a feed reverses and backlash is taken up. At somewhat higher speeds, the transient error at this point is apt to be equal to roughly 25 per cent of the backlash, and at feed speeds of 100 inches per minute, it has been observed to be as large as three times the backlash. At normal operating speeds, the control will compensate for a large part of the backlash. Also, circuits are included which minimize the possibility of any hunting action in the backlash zone.

Stickiness. Stickiness of the machine ways produces different detrimental results. Its effect is most pronounced when associated with drives having considerable windup.

With the electronically controlled feed drives used for tracer control, it is possible to operate the feed motors smoothly at extremely low speeds such as are required for machining a surface very nearly in line with a machine axis. For example, assume a slope with respect to a machine axis of 0.002 inch per inch of length. To machine this, one motor must run at 1/500 the speed of the other. In addition, the entire drive may be slowed down to 10 per cent of its maximum operating speed. This means that the slower motor must run at 1/5,000 of its rated speed. The electronically controlled drive is capable of this operating range.

If a machine slide tends to stick, the motor will wind up the drive shafts until enough force is obtained to move the slide. At this point, the spring effect will drive the slide until the spring is unwound and then will repeat. This obviously will produce a surface consisting of a series of steps rather than being smooth.

This stickiness has been evident on many machines during initial testing. Observation made of motor speed and slide travel, in the case of one of these tests, illustrates its serious effects. The drive on this machine was geared for approximately 0.0005-inch feed per revolution of the feed motor and had a very compact gear box but a relatively long lead screw. By operating the motor at approximately 10 rpm (0.005-inch per minute feed), the motor tachometer indicated less than 5-per-cent variation in motor speed but the slide on the machine jumped some 0.003 inch or 0.004 inch at roughly 1-minute intervals. After correction, this machine ran at even lower speeds with almost unmeasurable jumps.

The elimination of this stickiness is extremely important in tracer-controlled machines because of the extremely slow feed rates that may be required on some cuts. It usually can be eliminated by the correct machine adjustment and the use of a high-pressure lubricating oil on the ways.

Vibration. Vibration of the machine can have, of course, all of its usual effects upon the work being machined and can be detrimental, as well, to tracer operation. The tracing heads normally operate with the stylus deflected only a few thousandths of an inch and even 1/1,000 change in the amount of this deflection will cause a very large correction action in the control. Thus, it can be seen that a vibration of any appreciable magnitude can upset the tracer considerably.

The first thing to be done is to reduce vibration in the machine as much as possible, but then recognizing that any machine will vibrate to some extent, the most rigid possible mounting for the tracing head must be provided. A long, thin support for the tracing head will tend to amplify vibrations existing in the machine.

In general, backlash, windup, stickiness, and vibration fall within the position loop of the system and can be compensated for to some extent by circuit design and adjustments. The resultant system is a compromise, however, and will have its performance limited by these factors.

Deflections. Deflection of the machine members, of course, causes additional errors in the work. On a horizontal milling machine, the tracing head normally would be mounted directly above the cutting tool. Since the control causes the tracing head to follow the template, the tool must maintain continuously exactly the same relative position with respect to the tracing head if accurate work is to be done. It can be seen easily that only a very slight deflection of the machine column will cause this relative position to change appreciably.

On one vertical boring mill which performed very erratically, it was found that the ram tilted on its ways upon reversal of the feed drive. This tilt amounted to about 0.0015 inch in the 2-foot gib length, but because of the tool and tracer arrangement it showed up as about 0.005 inch in the work. Without tracer control the machine performance would not have been affected appreciably by this tilt.

Machine deflections may or may not lie within the position control loop of the tracer. If they are within the loop they may be partially compensated, but if outside there is no compensating effect.

Alignment. As with all machine tools, it is important that the usual alignment of elements be maintained and in addition that the tracer head be adequately adjustable while maintaining alignment. The result of misalignment of the tracer head is an error in the work even though the setup conditions appear perfect.

Errors in alignment of the machine itself lie within the position loop and can be compensated partly by tracer operation. Errors in alignment of the tracer head and template are not compensated however.

CORRECTION OF MACHINE DEFICIENCIES

MUCH MAY be accomplished in improving the machine deficiencies which give trouble in tracer operation. The machine itself may be improved and/or the control can be made to compensate.

Backlash. When trying to minimize backlash in a machine, it is important to understand what is causing it. The two principal places where it occurs in large amounts are between the leadscrew and the nut, and in endplay of the leadscrew. The usual result of an attempt to reduce the play between the screw and nut by tightening double, split, or other adjustable nuts is to bind up the drive at some point on the screw while it runs freely at another. This condition can be improved by increased precision in the machining of the screw and nut. The ultimate may be the use of a ball-bearing nut which can be preloaded very heavily without binding.

Backlash introduced by endplay in the leadscrew or nut, whichever is the rotating element, can be reduced to a small value by good preloaded bearing techniques. Ball and roller thrust bearings can be adjusted to essentially zero endplay.

Backlash in the gearing which drives the leadscrew or nut is seldom a major factor if the gears will run together quietly as gears should. For example, assume a leadscrew with 1/4-inch lead and a 3-inch pitch diameter gear driving it. The circumference of this gear is close to 10 inches giving roughly 0.025-inch feed per inch of circumference. A slack of 0.010 inch between this gear and the next one in the train then would introduce only 0.00025-inch backlash in the drive. The next gear in the train will have even less effect because of the step-up ratios involved.

An example of the fact that the backlash can be low, although a long gear train exists, is shown in Fig. 5. This is approximately the gear train of one machine with which the 2-dimension tracer is used. In 16 drives that have been tested to date, the total backlash in this gear train has been between 0.003 inch minimum and 0.007 inch maximum as measured at the slide.

The minimization of backlash involves the use of precision machining, preloading, antifriction techniques, and husky elements. Its reduction does cost money and must be balanced against the value of the improved performance which may be obtained.

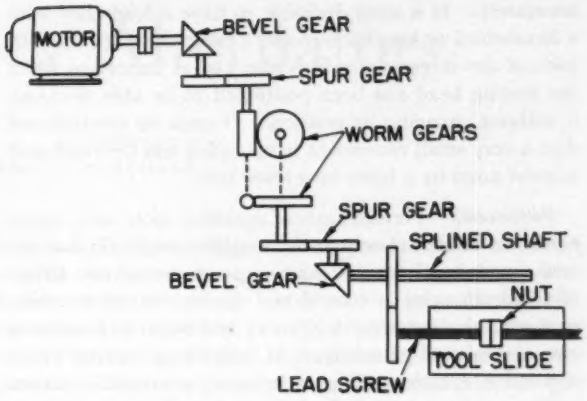


Fig. 5. An approximate gear diagram of a feed gear system which has been built consistently with less than 0.007-inch backlash from motor to slide

Windup. Windup is the result of elastic deformation of machine elements caused by the forces required to drive the machine motions. It may stem from twist of screws and shafts or deflection of their supports. It is characterized by being a spring effect and may be minimized by the use of closely coupled sturdy parts, and by reducing the friction, opposing movement of the machine member.

Stickiness. Stickiness is the result of variation in the friction between sliding surfaces. Its major cause is the difference between the force required to cause initial motion and that required to maintain motion. It is affected by the nature of the sliding surfaces and the lubricant used. Good, smooth bearing surfaces lubricated with special high-pressure oils help tremendously. For any given machine design, considerable study may be required for its elimination.

Vibration. Vibration in machine tools using tracer control breaks down into two problems: its reduction and the prevention of its transmittal to the tracer head and template. Improvement in geared drives and increased rigidity of machine parts will help reduce the vibration. Very rigid mountings for the tracer head and template will help eliminate its amplification by these parts.

Deflections. Machine deflections can be reduced by increased rigidity. Their effects can be decreased by good tool-tracer, work-template arrangements. For an example of the latter, if the arrangement of the tool-tracer combinations is such that a deflection moves the tool in one direction and the tracer in the opposite direction (not usual), the deflection effect is multiplied by a sizable factor.

Alignments. Machine alignment is not generally a serious problem because of its importance in the machine tool whether a tracer is used or not. However the mounting of the tracing head that its alignment can be maintained requires additional consideration. In setting up the machine, the work and template first may be placed in position. The tracing-head stylus then must be moved so that it has the same position relationship to the tool that the template does to the work. For this reason, it is important that the operator be able to position the tracer

accurately. It is most desirable to have a leadscrew with a handwheel or knurled nut and a fairly accurate scale for each of the three axes. It is also just as important when the tracing head has been positioned to be able to clamp it without changing its position. It must be remembered that a very small movement in clamping can be multiplied in some cases by a fairly long lever arm.

Performance. Performance of machine tools with tracer control is related closely to the machine condition and the feed speeds involved. At higher speeds the adverse effects of the deficiencies in control and machine are much more pronounced; however, tolerances and finish requirements also are relaxed generally. At lower feed speeds, where requirements are usually most stringent, operation improves until at extremely low feed rates the effects of inherent machine and control deficiencies essentially disappear.

Measurement of tracer performance is difficult because of the work shapes which require this type of control. Surfaces usually are made up of compound curves with few straight faces available for measurement.

The tracer-control equipment, however, provides a means for readily determining the error between the tracer stylus and the template. A tracer deflection voltage is available which can be read by either a meter or recorder and indicates directly any such error. Tests have shown that this error voltage can be relied upon to show the errors in the work as long as the tool-stylus and work-template relationships have not been disturbed by machine deflections.

High-Speed Milling. At the upper extreme of the range of tracing feed speeds, which have been observed, is a small milling machine capable of machining at feed rates up to 100 inches per minute. This machine has a backlash of 0.007 inch, little windup, and practically no stickiness. At 100 inches per minute the machine will follow shapes having curvatures of 1-inch radius with an accuracy of ± 0.015 inch. The limiting factor under these conditions is the machine backlash.

At lower feed speeds, performance on the same machine improves until at a half inch per minute, (obtained by a gear change) the accuracy is plus or minus 0.0005 inch over an almost unlimited series of template shapes. Backlash again is the limiting factor.

Low-Speed Turning. At the extreme low end of the range of feed speeds are the large boring mills used for difficult machining of materials such as stainless steel. The performance of considerable numbers of these machines has been observed on production work.

One series of machines turning jet-engine rotors have consistently been producing finishes of 50 microinches RMS on gentle compound curves. Small backlash marks are evident but not objectionable.

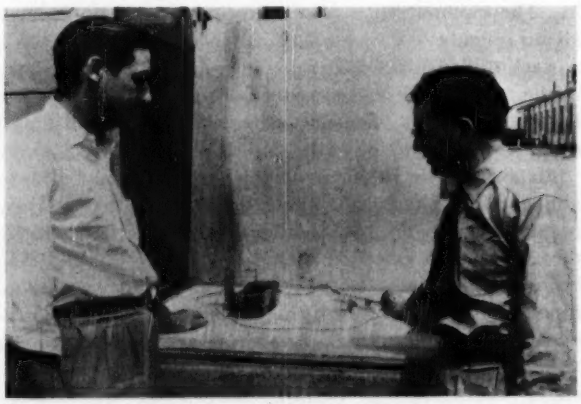
One automatic machine operation successfully runs through a sequence involving feed speeds of about 2 inches per minute while cutting, with a speedup to 75 inches per minute for traverse between cuts. No cutting was done during this traverse operation but the tracer was required to maintain contact with the template and be ready to cut immediately at the end of the traverse operation. Accuracies maintained were better than 0.0005 inch while machining.

Light Converted Into Electricity With Cadmium Sulphide Crystal

A successful method of converting light into electric energy has been developed by the Wright Air Development Center. A miniature generator has been made capable of supplying enough current to operate an electric clock. By increasing its size, making some other improvements, and hooking a number of them in relays it is possible to step up the voltage. The conversion powers of the generator are so great that a wafer-thin slab or crystal 4 feet by 15 feet, either resting on or built into the roof of a house, will supply enough current to operate all its lights, stove, refrigerator, and other appliances, 24 hours a day.

The secret is in the use of cadmium sulphide which when processed into crystal form permits a direct conversion of light into electric impulses. The crystal in the first model is about the size of a sugar cube, but it need be only wafer thin to work efficiently. Attached to opposite sides of the crystal are electrodes. One, made of silver, is the positive electrode. The other, made of indium, a soft metal normally used as an alloy in some bearings, is the negative. A wire running from the positive electrode to a motor or battery and back to the negative electrode forms the circuit. In use, light striking the crystal-electrode interface induces a direct potential carried out by means of the electrodes.

While the first model is crude, increased power is anticipated by making the electrodes transparent and facing the negative electrode into the sun and by improved methods of attaching the electrodes to the crystal.



D. C. Reynolds (left) and Lt. Col. G. M. Leies, senior investigators of the Wright Air Development Center project, observe the solar generator as it turns a small d-c motor at 73 rpm

High-Frequency Alternators

S. E. RAUCH L. J. JOHNSON
ASSOCIATE MEMBER AIEE

High shaft speeds, which permit direct coupling of alternators to high-speed turbines, have made the largest contribution to the increased power ratings of alternators. Consequently, high-frequency alternators are becoming widely used in air-borne equipment. These alternators should find many other applications as in computer and telemetering systems, welding applications, and arc lighting.

THE trend for high performance aircraft and guided missiles to operate in the range of supersonic speeds has placed an increasing demand on very precise and rapid controls in order to limit errors to acceptable values. The growing complexity of the systems has imposed an additional demand for miniaturization and increased power per unit volume. It is recognized that the standard auxiliary equipment using 400-cycle supply is approaching the design limits for further reductions in weight, volume, antl errors. However, these limits can be materially improved by the introduction of higher frequency power.

An illustration of the significance of increasing frequency for reduction of weight and volume can be easily seen in Figs. 1 and 2. Fig. 1 shows a 60-cycle-per-second (cps) motor-generator set of 80-watt rating,and a 2,400-cps motor-generator unit having a 500-watt output is shown in Fig. 2. The 60-cycle set has an approximate volume of 250 cubic inches and a weight of 35 pounds. The 2,400-cps set contains only 90 cubic inches with a corresponding weight of 8 pounds.

Figs. 3 and 4 show comparative typical control apparatus for 400 and 4,000 cps. Fig. 3 is a 25-watt 400-cps magnetic amplifier which has a response limit of 2.5 milliseconds. In contrast, in Fig. 4 there is shown a 25-watt 4,000-cps magnetic amplifier with a response of 0.25 millisecond. It is seen that not only weight and volume but also response time have been materially improved with increased supply frequency.

The advantages to be obtained from the use of high frequency are now becoming available through the recent developments of high-frequency alternators. These alternators have inherently the properties of large power per unit weight and volume, low inertia, high shaft speed, reliability, and long life.

This article presents a summary of the technological advances which have led to the realization of reliable lightweight high-frequency alternators. In addition there is shown the characteristic of a typical alternator which is used in high performance systems. The alternator can deliver a power-to-weight ratio of 1 kw per pound and has a maximum power rating of 3 kw.

Full text of a conference paper presented at the AIEE Summer and Pacific General Meeting, Los Angeles, Calif., June 21–25, 1954, and recommended for publication by the AIEE Committee on Air Transportation.

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DESIGN PRINCIPLES

THE fundamental voltage equation for a generator is given by

$$E_g = Nprps\phi_p f 10^{-8} \quad (1)$$

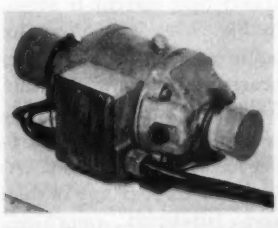
where E_g is induced voltage in rms volts, N is the number of turns in series, p is the pairs of poles, rps is the revolutions per second, ϕ_p is the working flux in maxwells per pole, and f is the flux distribution factor.

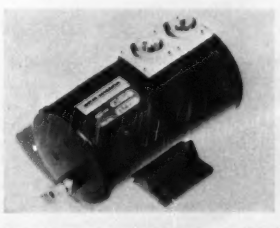
The output power of the generator can be determined by

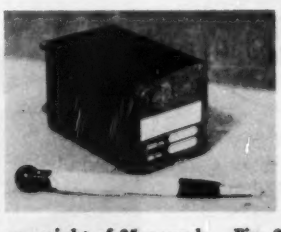
$$P = \frac{E^2}{R} \quad (2)$$

where P is power output in watts, E is the terminal voltage, and R is the resistive load. The short-circuit power of the generator is given by the ratio of E_g^2 to the internal resistance r of the generator, assuming no reactance. The maximum output power is equal to

$$P_{max} = \frac{(E_g/2)^2}{r} \quad (3)$$







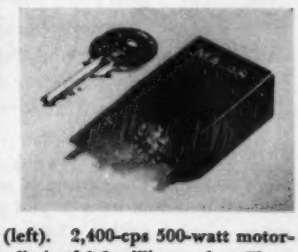


Fig. 1 (far left). Typical 60-cps 80-watt motor-generator set, having a weight of 35 pounds. Fig. 2 (left). 2,400-cps 500-watt motor-generator set weighing 8 pounds. Fig. 3 (right). 400-cps 25-watt magnetic amplifier with a response limit of 2.5 milliseconds. Fig. 4 (far right). 4,000-cps 25-watt magnetic amplifier with response limit of 0.25 millisecond

since the maximum power output is obtained when the resistive load is equal to the internal generator resistance. At this time the voltage across the load is only one half of the total generator voltage.

The internal resistance of the generator is given by

$$R = \rho l_m N^2 / A_c \tag{4}$$

where ρ is the resistivity of the conductor, l_m is the mean length of a conductor turn, N is the number of turns in series, and A_c is the total copper cross section. Thus the fundamental output equation of a generator can be written as

$$P_{max} = \frac{(p\phi_p rps f 10^{-8})^2 A_c}{4\rho l_m} \tag{5}$$

Alternators which are now being built are obtaining their large power ratings because of considerable advances in the past decade in the quality of both electric and mechanical materials. The two major aspects of alternator design which have significantly improved the power per unit weight are increased *rps* and increased B_p, where B_p is the flux density of the poles. Let us consider the possible improvements which can be made today which were not practical 10 years ago.

Power per unit weight:

1. Increase in shaft speed.
2. Improvement of magnetic materials.
3. Increase in frequency.

Duty cycle:

1. Improved bearing and lubricants.
2. High-temperature insulating materials.
3. Thinner magnetic sheet material for laminations.

The greatest contribution to the increase in power per unit volume has been realized through the availability of high-speed bearings. Ten years ago the practical upper limit for ball bearing speeds was in the order of 20,000 rpm. In contrast a precision bearing of the same size today can be operated continuously at 50,000 rpm with an expected life of 1,000 hours or more. Since the maximum power output is proportional to the square of the shaft speed, as can be seen in equation 5, then realizable power outputs per unit volume have been increased sixfold.

Another major improvement has been accomplished through the metallurgical advances in magnetic materials. It has been possible to increase working flux densities from 12,000 gauss to 16,000 gauss while at the same time to reduce the core losses by a factor of at least two. Thus an additional 50-per-cent increase in the maximum power output has been achieved through the use of improved magnetic materials.

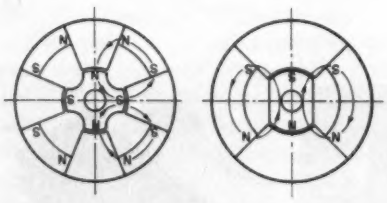
Increasing frequency has been a natural result of the increased shaft speeds. A further contribution to the maximum power rating is achieved by the use of multiple pairs of poles. For example, see Fig. 5, which shows the cross section of a 2- and 4-pole stator. In the 4-pole stator the magnetic yoke is only one half the volume which is needed for a 2-pole stator when the total flux of the alternator is kept constant. This is a result of the distribution of the flux. In the 2-pole machine, each yoke must carry one half the total flux, whereas in the 4-pole machine each yoke carries only one fourth the total flux. For the same operating flux density, only one half the yoke cross-section area is needed, which thus provides a 50-per-cent reduction in yoke volume for the 4-pole unit. It is desirable therefore to increase within practical limits the number of pairs of poles in the alternator stator. An increase of 10 to 20 per cent in power per unit weight and volume can be expected through the use of multiple pairs of poles.

The duty cycle has been improved by the use of low-loss magnetic materials and lubricants. Reduction of losses decreases the amount of heat developed in the alternators, which in turn allows a larger proportion of heat to be generated in the windings for a given temperature rise. The allowable temperature rise of alternators has been increased through the use of high-temperature insulating materials, such as silicone compounds, Teflon, glass, and ceramics. Previous maximum temperatures were usually kept below 100 C. Using the latest high-temperature bearing lubricants and electrical insulations, the operating limits of temperature are now approaching 250 C.

A TYPICAL ALTERNATOR

As an illustration, consider a 5,000-cps alternator which uses permanent magnet excitation and employs the varying reluctance principle, see Fig. 6. This is a representative alternator which is available on the market as a production item and therefore is a realistic example of recent developments using the materials discussed previously.

This unit, when operating at 50,000 rpm, produces 3 kw at 5,000 cps. The power output and voltage regulation versus load current is shown in Fig. 7. The alternator features precision high-speed bearings, silicone varnish-insulated wire, and silicone rubber-impregnated glass fiber for stator insulation. As the rotor consists only of shaft and laminated punchings, there are no commutation or sliding contact problems.



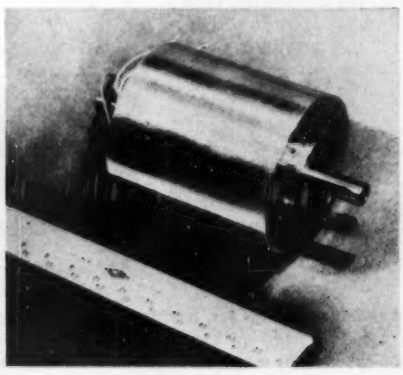
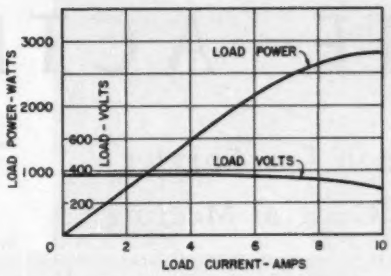


Fig. 5 (above). Comparison of magnetic yoke cross section for a 2- and a 4-pole stator. Fig. 6 (right). 5,000-cps 3-kw high-frequency alternator weighing 3 pounds

Permanent magnets are used in order to simplify the means for excitation as well as to minimize weight and volume. The magnets are protected against demagnetization from short-circuit faults with the use of internal magnet shielding.

The alternator described has over-all dimensions of 3 inches length, not including shaft extension, and a diameter of 2.75 inches. The power per unit weight exceeds 1 kw per pound. Although the dimensions are representative of what is being commonly achieved now, they are not the ultimate in design. More recent developments are indicating that performance characteristics exceeding those described in this article can be achieved.



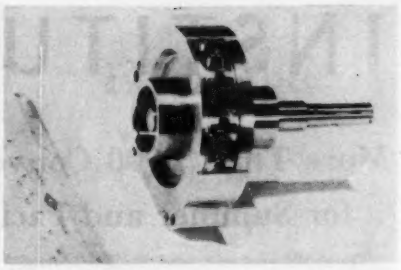


Fig. 7 (left). Power output and voltage regulation versus load current for alternator shown in Fig. 6. Fig. 8 (right). Typical turbine drive for high-frequency alternators

CONCLUSIONS

It has been shown that high shaft speeds have made the largest contribution to the increased power ratings of alternators. High shaft speeds permit direct coupling of alternators to high-speed turbines, which are now becoming widely used in air-borne equipment. Fig. 8 shows a typical combination of alternator with its turbine drive. A natural outgrowth of the high-speed rotating power units has been higher frequency, which yields large reductions in volume and weight of electromechanical components in systems.

Although aircraft application has been the major impetus in the development of high-frequency alternators, it is important to note that these alternators also can improve the processes and systems in commercial fields. The direct application of high-frequency power for computer and telemetering systems will improve system reliability and increase the rate for data transmission. Servo motors operating from higher frequency supplies can have increased torque with reduced inertia properties, while at the same time they require less weight and volume. High-frequency power in welding applications improves the homogeneity of the weld as well as reducing the sputtering and irregularity. Another improvement in commercial applications is found in the use of high frequency in arc lighting, which reduces flicker and produces a more uniform electrode erosion pattern.

Motor-generator sets producing high-frequency power can be obtained with power ratings ranging from 50 watts to 10 kw and frequencies from 400 to 10,000 cps.

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Product Evaluation Plan

In the Reduced Inspection Quality Assurance Plan (RIQAP), the U. S. Signal Corps has initiated a new approach to product evaluation and acceptance. Designed to assure maintenance of highest quality standards, RIQAP shifts emphasis from product inspection by placing increased reliance on the manufacturer's quality control policies and practice. This new program is selective, not only of manufacturers in general, but also of the specific products of any one producer. Only those items whose quality control history can be extensively evaluated are subject to choice. By this multiple selectivity the Signal Corps assures itself of reliable products and lowered inspection time. RIQAP does not rely solely on an appraisal of a contractor's quality control system; periodic, unscheduled product inspections are included in the plan. RIQAP is not incorporated by specification into a contract; it is a voluntary agreement entered into by the contractor and the Signal Corps after a sufficient high quality history has been established. To get Signal Corps consideration a manufacturer must initially satisfy stringent quality requirements and then, to get approval, must submit a detailed inspection plan covering his own quality control and inspection programs and have this plan accepted.

INSTITUTE ACTIVITIES

More Than 2,000 Convene in Los Angeles for Summer and Pacific General Meeting

The AIEE Summer and Pacific General Meeting was held in the Biltmore Hotel, Los Angeles, Calif., June 21–25, 1954, and was attended by 2,069 members and guests. In addition to the Annual Meeting on the first day, there were 56 technical sessions at which 237 papers were presented, these being divided as follows: 39 technical papers on communications and electronics, 24 on applications and industry, 57 on power subjects, and 117 conference papers.

Twelve inspection trips to various industrial plants in the vicinity were well attended. On the social side, evening trips to television studios, Mt. Wilson Observatory and television studios, and Knott's Berry Farm were enjoyed with the highlight on Thursday evening when the President's reception and banquet was held in the Biltmore Bowl, at which time the golf prizes were awarded. The ladies' entertainment included trips to the different parts of Los Angeles, its beaches, and stores, with luncheons at the Padua Hills Restaurant and the Wilshire Country Club. On the first 4 days of the meeting luncheons were held at which prominent speakers talked on timely subjects.

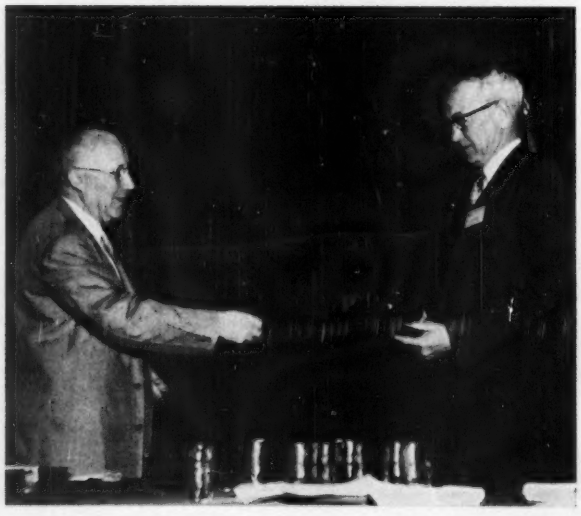
ANNUAL MEETING

Bradley Cozzens, chairman of the General Meeting Committee, opened the Annual Meeting of the Institute, introduced the meeting committee chairmen, and Jack Irwin, Deputy Mayor of Los Angeles, who welcomed the visitors to the city. The meeting then was turned over to AIEE President Elgin B. Robertson, who made his report on the finances, publications, and other activities of the Institute. (For Mr. Robertson's report, see pages 692–4).

AIEE Secretary N. S. Hibshman then summarized the Board of Directors' and the Treasurer's Reports (see page 755) after which he read the report of the Committee of Tellers on the vote for nominees for AIEE offices. These were as follows: for *President*, A. C. Monteith; for *Vice-Presidents*, G. J. Crowdes, J. P. Neubauer, C. M. Summers, S. M. Sharp, and J. R. Walker; for *Directors*, L. M. Hickernell, R. E. Kistler, and E. S. Lammers, Jr.; for *Treasurer*, W. J. Barrett.

President Robertson briefly told the members about some of Mr. Monteith's accomplishments and then presented him with the President's badge. After expressing his gratitude for the honor, Mr. Monteith said he had noted the improvement in the various committees' responsibility and their spirit of co-operation. Better co-operation between engineering societies is essential and this idea must be passed on to undergraduate students, who should also learn to be of value to their communities as well as to their engineering societies. A broad educational program is necessary so that the public will know that engineers can bring responsibility and leadership to the community at large.

Mr. Robertson then announced one of the more pleasant duties of the President: the awarding of the Lamme Medal to F. A. Cowan, American Telephone and Telegraph Company, "for his outstanding contributions to long distance communications and the development of modulating and transmission apparatus of original design and application." Mr. Monteith told about the establishment of the medal, J. J. Pilliod gave the career of the medalist, and after the presentation of the medal, Mr. Cowan in his response told about the advances made in



Past President McMillan presents the portfolio of letters of appreciation and the Institute's gift of a pair of binoculars to the retiring secretary, H. H. Henline

Future AIEE Meetings

Symposium on Information Theory
Massachusetts Institute of Technology, Cambridge, Mass.
September 15–17, 1954
(*Final date for submitting papers—closed*)

Petroleum Technical Conference
Mayo Hotel, Tulsa, Okla.
September 27–29, 1954
(*Final date for submitting papers—closed*)

National Electronics Conference
Hotel Sherman, Chicago, Ill.
October 4–6, 1954
(*Final date for submitting papers—closed*)

Middle Eastern District Meeting
Abraham Lincoln Hotel, Reading, Pa.
October 5–7, 1954
(*Final date for submitting papers—closed*)

Fall General Meeting
Morrison Hotel, Chicago, Ill.
October 11–15, 1954
(*Final date for submitting papers—closed*)

Machine Tool Conference
Hotel Statler, Detroit, Mich.
October 25–27, 1954
(*Final date for submitting papers—closed*)

Mid-Atlantic Textile Conference
North Carolina State College, Raleigh, N. C.
November 4–5, 1954
(*Final date for submitting papers—August 4*)

Conference on Electrical Techniques in Medicine and Biology
Morrison Hotel, Chicago, Ill.
November 10–11, 1954
(*Final date for submitting papers—August 10*)

Eastern Computer Conference
Bellevue-Stratford Hotel, Philadelphia, Pa.
December 8–10, 1954
(*Final date for submitting papers—September 8*)

High-Frequency Measurements Conference
Hotel Statler, Washington, D. C.
January 17–19, 1955
(*Final date for submitting papers—October 18*)

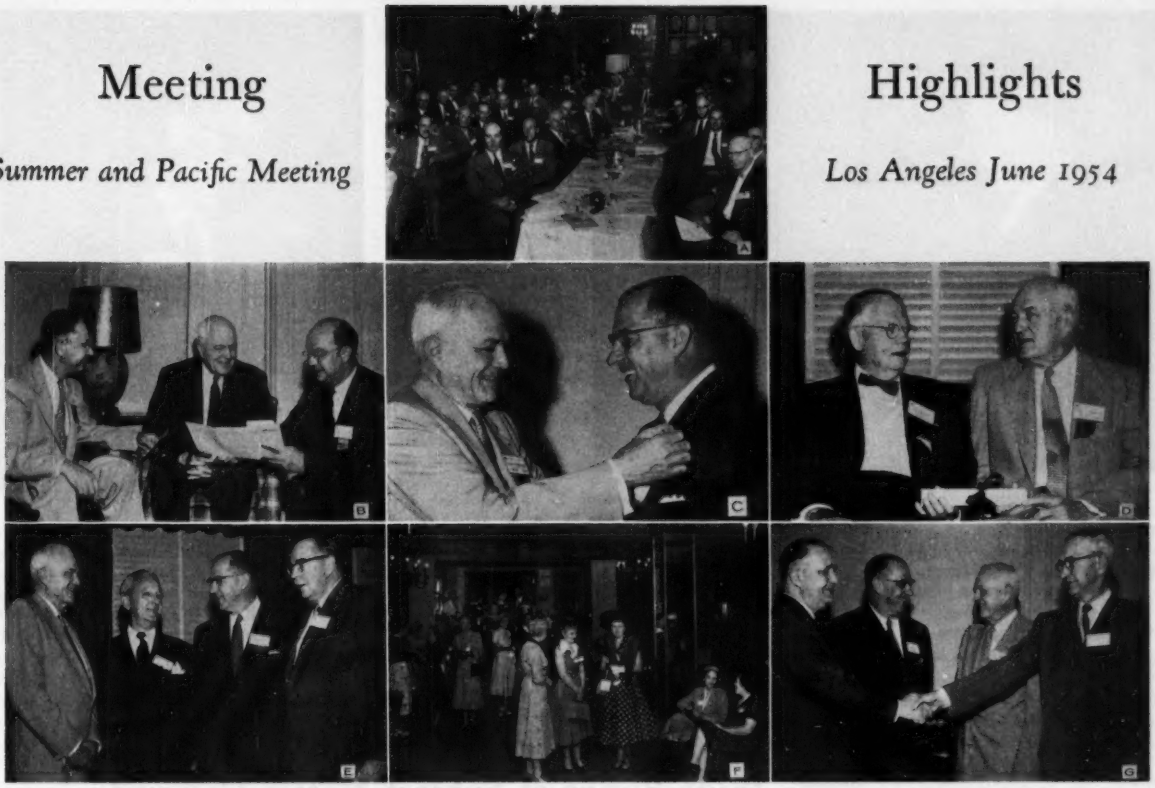
Winter General Meeting
Hotel Statler, New York, N. Y.
January 31–February 4, 1955
(*Final date for submitting papers—October 20*)

Southern District Meeting
St. Petersburg, Fla.
April 13–15, 1955
(*Final date for submitting papers—March 29*)

1955 Summer General Meeting
New Ocean House, Swampscott, Mass.
June 27–July 1, 1955
(*Final date for submitting papers—March 29*)

Meeting Highlights

Summer and Pacific Meeting — *Los Angeles June 1954*



(A) Board of Directors' Meeting. (B) Meeting Vice-Chairman E. K. Sadler discusses the program with President Robertson (center) and General Chairman Bradley Cozzens (right). (C) Mr. Robertson presents the President's badge to A. C. Monteith. (D) R. W. Sorensen (left) receives the certificate of Honorary Membership from Mr. Robertson. (E) In informal discussion are President Robertson, District 8 Vice-President G. C. Tenney, President-Elect Monteith, and the Lamme Medalist, F. A. Cowan. (F) Hospitality Room at Ladies' Headquarters. (G) Retiring Secretary H. H. Henline and President Robertson (at right) greet their successors, N. S. Hibshman and A. C. Monteith

long-distance telephone communications. (See pages 714–18.)

The President than gave a biographical résumé of Dr. R. W. Sorensen to whom was presented a certificate of Honorary Membership in the Institute.

Mr. Robertson introduced Past President McMillan who spoke of the past 22 years during which Henry H. Henline had served the Institute as Secretary. Professor McMillan had requested the past presidents who held office during the retiring secretary's regime to write letters of appreciation to Mr. Henline. Excerpts were read from 15 of these letters, which were presented to Mr. Henline together with a pair of binoculars. (See pages 690–1.)

FOUR SPECIAL LUNCHEONS

Four special luncheon meetings, addressed by prominent electrical engineers and scientists, were features of the meeting. The speakers discussed some of the vital engineering subjects of the day, peacetime use of atomic energy, the role of electricity in the development of the West, and education.

George C. Tenney, San Francisco, Calif., Vice-President of the Institute and editor of *Electrical West*, was the luncheon speaker on Monday, June 21. He discussed the role of electricity in the development of the West during a general talk on the Diamond Jubilee of Light. Mr. Tenney was presented by E. K. Sadler, vice-chairman of the General Committee.

Walker L. Cisler, president and director of the Detroit Edison Company and an authority on peacetime use of atomic energy, was the Tuesday luncheon speaker. His subject was "A Realistic Approach to Atomic Power," during which he discussed the various reactor developments under way, the problems involved in converting atomic energy to peacetime use, and current progress in this field. E. W. Morris, chairman of the meeting's Technical Program Committee, presided at the luncheon.

Dr. Lee A. DuBridge, president of the California Institute of Technology, spoke on "The Goals of University Research" during the Wednesday, June 23, luncheon. He analyzed the responsibilities of the universities in the field of education, in the conduct of pure science and applied research, and their responsibilities for the provision of technical services for public agencies and for the public welfare.

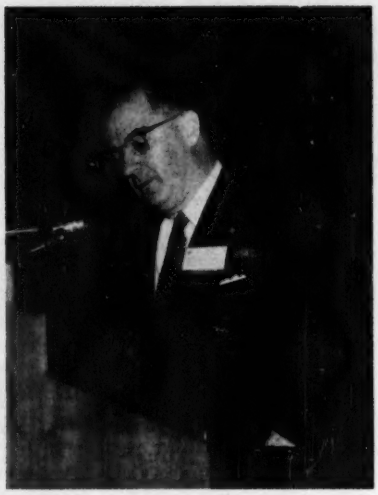
At this luncheon, President Elgin B. Robertson presented the winner of District 8 competition, W. E. Houston of the University of California at Berkeley, and introduced the winners in the other nine Districts, whose expenses to Los Angeles were paid from the Members-for-Life fund. Professor Louis L. Grandi, chairman of the Students Committee, presided.

The Eta Kappa Nu luncheon was held Thursday, June 24, with Dr. Lee de Forest, eminent radio scientist and inventor, as the principal speaker. E. T. B. Gross, president of Eta Kappa Nu, called attention to the 1954 Golden Anniversary of this society, which cannot be held at Urbana, Ill., in October where it was founded because of the football game. Upsilon Chapter of the University of Southern California and the Los Angeles Alumni Chapters were co-sponsors of this luncheon.

BANQUET AND AWARD OF SPORTS PRIZES

The banquet was held on Thursday evening in the Biltmore Bowl. Bradley Cozzens, chairman of the Summer and Pacific General Meeting Committee, paid tribute to the members of the committee who made the arrangements and President Robertson expressed his appreciation.

Golf Tournament. The John B. Fisken cup was won by C. B. Oler, associate professor of electrical engineering, U. S. Navy Postgraduate School, Monterey, Calif., with a low gross of 75 and a low net of 68. The prize consisted of a silver ice bucket. The second low gross of 76 carrying a prize of a silver tray was won by P. W. Berthold, Akron, Ohio. The low net of 69 with a prize consisting of a silver cocktail shaker was won by D. L. Trott, a guest mechanical



(Left) W. S. Peterson (left) introduces the speaker at the Tuesday luncheon, Walker Cisler of the Detroit Edison Company. (Right) President-Elect A. C. Monteith addresses the Annual Meeting

engineer from Los Angeles. Second low net with a score of 73 was won by O. A. Gustafson of San Francisco who was awarded a silver water pitcher. Winners in the blind bogey were Fred Cole, A. W. Cartmell, M. A. Moler, and John Harrigan.

Tennis Tournament. The singles was won by George Palka with K. H. Meissner as runner-up. George Palka and Charles Short won the doubles with the team of W. C. King and J. W. Reinhard runners-up.

Following the award of sports prizes an all-star cast of entertainment: the Duncan Sisters, Lucille Norman, Gene Sheldon, the Sportsmen from the Jack Benny Show, and others, with Chick MacGregor, master of ceremonies, was well received by an enthusiastic audience.

SUMMER AND PACIFIC GENERAL MEETING COMMITTEE

Officers of the General Committee and members at large were as follows: Bradley Cozzens, chairman; E. K. Sadler, vice-chairman; Clarence Wells, secretary; D. I. Cone, Director; R. W. Sorensen, president, 1940–41; Thomas Ingledow, Vice-President, District 9; G. C. Tenney, Vice-President, District 8; and F. O. McMillan, president, 1951–52.

The chairmen and vice-chairmen of working committees which made the arrangements were as follows: Entertainment, C. M. Allen, chairman, and R. E. Johnson, vice-chairman; Hotels, Charles Croft, chairman, and Ed Danielson, vice-chairman; Inspection Trips, R. L. Engel, chairman, and R. Klumb, vice-chairman; Students, L. L. Grandi, chairman and A. E. Mathews, vice-chairman; Sports, G. B. Kirkwood, chairman, and A. W. Jensen, vice-chairman; Finance, H. A. Lott, chairman, and G. R. Woodman, vice-chairman; Arrangements, Robert Milmoe, chairman, and C. L. Sidway, vice-chairman; Technical Program, E. W. Morris, chairman, and J. W. Savage, vice-chairman; Publicity, Elmer Niemoeller, chairman, and Eric Tugby, vice-chairman; Registration, H. J. Wheeler, chairman, and R. D. Turpen, vice-chairman; Transportation, R. A. Young, chairman, and A. C. Werden, vice-chairman; Ladies Events, Mrs. E. K. Sadler, chairman, and Mrs. Bradley Cozzens, vice-chairman; Information Desk, Mrs. E. W. Morris, chairman, and Mrs. C. M. Allen, vice-chairman; Hospitality and Coffee Hour, Mrs. E. S. Condon, chairman, and Mrs. H. W. Tice, vice-chairman; Ladies Transportation, Mrs. G. F. Rucker, chairman, and Mrs. R. A. Young, vice-chairman; Tea and Fashion Show, Mrs. G. B. Kirkwood, chairman, and Mrs. F. L. Goss, vice-chairman; Tour and Padua Hills Luncheon, Mrs. F. Garrison, chairman, and Mrs. J. V. Vivian, vice-chairman; Forest Lawn Art Exhibits, Mrs. C. M. Cavner, chairman, and Mrs. P. E. Brackett, vice-chairman; Huntington Library Art Exhibits, Mrs. P. L. Johnson, chairman, and Mrs. C. A. Wells, vice-chairman; and Tour and Wilshire Country Club Luncheon, Mrs. T. M. Blakeslee, chairman, and Mrs. Harry Wittenburg, vice-chairman.

Wide Range of Subject Matter Covered at Summer Meeting Technical Sessions

Among the technical sessions for the opening day, one of the best attended was that in which color television was considered. "Color Television Today" was the subject of the first conference paper by D. E. Foster, Hazeltine Research, Inc., of California. After explaining how the channel arrangement is like that used for monochrome operation except for the added chrominance subcarrier, the author told how the signal was encoded and then described the receiver with its decoder and the Chromatron picture tube. The prediction was made that color television receivers will be on the market in the near future with 19-inch tubes, but that relatively soon this picture-tube size will be increased by 2 or 3 inches.

Dr. P. C. Goldmark, CBS Laboratories, described the color television system wherein a field sequential camera sends sets of signals to a converter, the Chromacoder, which changes the signals into those acceptable for the simultaneous or National Television System Committee system. The speaker stated that this system is more economical than the other even though three cameras are involved in the latter.

TRANSMISSION AND DISTRIBUTION

Several of the papers in two of the sessions dealt with transmission at the higher voltages and a paper on electrical clearances for transmission-line design at the higher voltages by P. L. Bellaschi, consulting engineer, aroused considerable interest. Another paper gave the results of tests on 230–330-kv structures, and still another brought the latest experiences from Sweden on their radio transmission on 230- and 400-kv lines. The third session was devoted entirely to distribution and had to do with overvoltages on 14.4/24.9-kv systems as well as the effect of load growth on economic conductor size, load area geometry, and a simplified method for capacitative reactance calculations.

RADIATION IN MEDICINE

Five conference papers were given in the session devoted to radiation instruments used in the medical field. C. A. Dubbs, Veterans Administration Center of Los Angeles, forecast that electrophoresis (the study of the movement of proteins in an electrically charged fluid field) can become an increasingly powerful diagnostic weapon. In certain diseases of the liver, kidney, and bone marrow, and in certain infectious states, blood plasma give quite definite electrophoretic patterns. While only a small amount of electric energy is used, an unwanted amount of heat is generated which has to be dissipated by electrical refrigeration and it is along this line that further research is indicated.

NUCLEAR POWER

The session on nuclear reactors dealt with both propulsion and power reactors. P. N. Ross, Westinghouse Electric Corporation, gave a brief description of the nuclear plant aboard the submarine *Nautilus* and then discussed the uses of different coolants in several

types of reactors. In the discussion following the paper, it was brought out that the safety area in the vicinity of a reactor is dependent on its power and operating characteristics. Although this is a rule-of-thumb formula and only approximate, there have been no adverse results on the health of people living near any of the plants.

Presenting a technical paper, "Electric Circuit Models of the Nuclear Reactor," Gabriel Kron, General Electric Company, stated that as the first large-scale industrial application of nuclear energy appears to be the generation of electric power, the electric power engineer is again being pressed to become acquainted with nucleonics and quantum mechanics. He gave a set of electric circuit models established for the linear partial differential equations for the diffusion of neutrons in a nuclear reactor of arbitrary shape. He represented the variable energy of neutrons as a fourth dimension and the variation of neutrons in time is introduced as an additional fifth dimension.

W. H. Nutting, Pacific Gas and Electric Company, considered the economic outlook for nuclear power. He stated that it was conceded that we have a sufficient fuel reserve to last for the next 200 years, but due to the increased use of electricity in the United States, a 25-per-cent increase, this estimate might well be off. It is assumed that the reserves of uranium are 25 times that of fossil fuels, but it must be remembered that the expensive part of a reactor is its components rather than the fuel. Future plants will be cheaper as more experience is gained, but the small plant is uneconomical as the power and capital costs decrease as the power output of the plant increases.

In the afternoon session devoted to nuclear measurements and accelerators, S. G. Thompson and Albert Ghiorso, of the University of California Radiation Laboratory, described how they checked for elements 98 and 99 and the very accurate method they employed. The other three conference papers in the session were descriptions of the accelerator at Stanford University, the current-accelerator at the University of California, and the synchrotron at the California Institute of Technology.

POWER GENERATION

One of the sessions on power generation was principally devoted to the outdoor type of steam stations and the other to hydroelectric generators. As reported by A. E. Capon, City of Burbank, Calif., there has been an increasing trend toward the outdoor types of plants even extending to areas where weather conditions are unfavorable because of the low construction costs. In this type of plant, there are construction problems in expansion and contraction as well as the pouring of the concrete decks to avoid cracks. Maintenance and repair in the hot sun on these decks are done under lower efficiency and there is the problem of noise in residential areas. The last paper presented in this session dealt with the design features of a 50,000-kw unit going into an indoor station at the Hawaiian Electric Company, Limited, and it was presented by W. J. Froome. He described the protective features, excitation, etc., which will improve the over-all operating reliability of the system. The added cost for bus differential relaying protection was questioned in discussion; but as this new unit will take the base load, the author explained that there was great economic justification for this type of relay protection.

The other session was on hydroelectric generators, and such subjects were treated as the nondestructive testing of mechanical components, maximizing the income from this type of generator, the development of small hydroelectric sites, and Tennessee Valley Authority experiences with vertical hydroelectric generator thrust bearings.

INSULATED CONDUCTORS

In two sessions on this subject, the trend toward higher voltages was noted as papers which dealt with the 300-kv oil-filled cables for the Kemano-Kitamat project were presented. The third paper dealt with the design and test results of pipe-type cables for power transmission at 230 kv and higher voltages. The second session dealt almost exclusively with pipe-type cable systems from such aspects of the subject as the pipe as a structure for high-pressure systems, the physical characteristics of faults in this type of system, and the use of aluminum conductors. The method of compression Y-splicing to insulated aluminum and the advantages were presented in a fourth paper.

INSTRUMENTS AND MEASUREMENTS

One of the more interesting technical papers presented at the session on instruments and measurements was by J. M. Shulman, Westinghouse Electric Corporation, on accurate tachometry measurements with electronic counters, which can measure short intervals of time up to 100,000 events per second. By modifying the basic counting system, they can be used for measuring rotating machinery by simple attachments to the shaft and with a series of four locked-in oscillators, which provides the electronic impulses so that revolutions per minute can be read directly.

C. W. Frick, General Electric Company, presented "The Quasi-Peak Voltmeter," which is used for measuring radio noise. Different types of pulses significant to radio noise were analyzed and it was stated that this investigation contributes the first of two steps necessary to the interpretation of radio-noise meter readings in terms of radio-noise nuisance value.

INSTRUMENTATION

In a session on instrumentation, W. R. Clarke, Leeds and Northrup Company, read two papers on an electronic air-borne temperature indicator and its stabilized power supply. This instrument, which is operated from 115-volt a-c line, can be operated and stored safely within a temperature range of ±55 C, the basic part being a special compensating circuit and a regulated power supply including two *5651* tubes. This device, which meets military specifications, has a limit of error of less than 0.1 per cent.

In this session H. F. Clarke, Boeing Airplane Company, presented, "A Survey of Noncontacting Vibration Pickups Using Electric Fields." He discussed the optical, mechanical, and other methods of vibration measurements which have been used, and then told about these functioning electrically. There are two microwave systems, one using a waveguide and magic tee and another using a directional coupler, the detector of which only picks up the reflected energy from the vibrating object.

ELECTRONIC CIRCUITRY

In a session devoted to electronic circuitry, K. A. Pullen, Jr., Aberdeen Proving Grounds, presented, "Use of Screen-to-Plate Transconductance in Multigrid Circuit Design." The use of this parameter was explained and also some of the more useful applications of the concept. One of the uses stressed was how this parameter can be employed in the matching of tubes for push-pull amplifiers.

The application of transistors to components of telemetering apparatus was considered by C. M. Kortman, Bendix Aviation Corporation. He described a subcarrier oscillator which has sufficient stability to be used in FM/FM telemetering applications over a temperature range from −50 to +60 C and in some instances even 10 degrees higher.

INDUSTRIAL APPLICATIONS

Four papers were given covering general industrial applications. The first of these described the remote operation of pipe-line pumping stations. A new packaged drive for a log carriage for the small saw mill where the carriage is Amplidyne controlled was explained by D. C. Burke, General Electric Company, and the advantages of a mechanical magnetic-amplifier speed-matching system for sectional paper machine drives were told by W. Schaelchlin and M. H. Fisher, Westinghouse Electric Corporation. K. D. Watt and J. P. Doyle, Alaska Pine and Cellulose Ltd., considered the control circuit design and its application for sulphite pulp bleaching in an automatic process.

In one of the final sessions of the meeting special communications applications were considered. Lloyd Espenschied, Bell Telephone Laboratories, read a historical paper covering some of the discoveries which raised the curtain on this electrical age. A discussion on magnetic tape recording systems was given by L. L. Fisher, J. B. Rea Company, Inc., in which he covered in detail the use of recording tapes in the different types of computers.

"Plan *6* Receiving Teleprinted Concentrator" was described by R. D. Swanson, Western Union Telegraph Company, which has been installed in several large offices.

SYSTEM ENGINEERING

In two sessions jointly sponsored by the Committees on Computing Devices and System Engineering several papers presented dealt with the theory of economical loading of power systems from the results of studies on what is known as operations research at the Massachusetts Institute of Technology for the Bonneville Power Administration (BPA). As explained by Professor Boehne, one method was applied to a simple one-dam system with the hope of establishing a philosophy of operation which would give the best economy. The problems of rates of flow and projected seasonal expectations combined with operating units at maximum efficiency for varying heads is very complex and served to illustrate the advantages of using high-speed computers for these types of problems. In the second session, a practical low-cost digital computer was described as well as the use of an analogue computer for automatic determination of system swing curves.

In another session on system engineering,

two papers brought the latest European practices to the fore. In the absence of the authors, W. S. Petersen presented the planning of the Swedish extra-high-voltage system, pointing out the geographical situation in which most of the resources are to the north where there is only 15 per cent of the population, which requires long transmission lines to the large centers of population in the south. In discussion, E. L. Kanouse drew attention to the ingenious way in which the fundamental principle of the use of series capacitors had been brought in to play to bridge the economic gap between a slow load growth and added generating capacity. This requires extensive planning with careful selection of the voltage, load requirements, and generating capacity. Another discussion by F. L. Lawton complimented the authors on a most constructive, thorough manner of system planning and inquired if the cost of $150 to $200 per kilowatt included the cost of autotransformers, switchgear, and cables.

The integration of the high-voltage systems in Britain beginning with the first stage in 1930 comprising the 132-kv national grid system and the present stage of the 275–300-kv supergrid scheme now under construction with tower designs for future operation at 380 kv was described by B. P. Sayres of the British Electricity Authority.

Plans for the integration of extra-high-voltage transmission lines within the BPA 230-kv grid were presented by G. C. Connor. With the completion of approximately 3,500,000 kw of federal generation within 10 years, the capacity of the BPA grid will be doubled. Autotransformers at both ends of the transmission lines with 230-kv switching permit maintaining the present single basic grid system without additional cost.

A fourth paper presented an economic study of the feasibility of supplying the Southern California area from a base load plant located at the mine in Utah over 660-mile transmission lines with compensating stations at the mid-point. Transient stability studies were made and the results of the economic load study yielded a minimum cost of transmitting energy when the receiving power was 700 megawatts per line. The presentation was made by H. D. Hunkins of the Bureau of Reclamation, and in discussion it was pointed out that the comparative studies were made on the basis of using 3 per cent in government financing and allowing nothing for taxes. A question was also raised in regard to the scarcity of cooling water in northern Utah.

In still another session on system engineering, great interest was shown in the discussion of a paper on the design and operation of system-wide automatic load-frequency control, which was presented by C. N. Metcalf of the Consolidated Edison Company of New York. Several apparatus sessions were held which dealt with carrier current, transformers, and switchgear. One of the switchgear sessions was principally devoted to capacitor switching and in another the field tests on the 138-kv Swedish low-oil-content circuit breakers were described.

Section Delegates Conference Considers Problems and Operational Procedures

AIEE election procedure, membership, new Sections, Section growth awards, rules for prize papers, student activities, and publicity were among the topics discussed at an all-day conference of Section delegates. Vice-Chairmen Bradley Cozzens (west), and Dickson Lewis (east), presided.

AIEE ELECTION PROCEDURE

Several of the delegates questioned the election procedure of presenting only one name on the ballots, not with the intent of criticizing this procedure but merely as a question of economy. The present procedure was outlined by Director C. S. Purnell who explained that the District Executive Committees meet in the fall, and as they include representatives from the Sections there is an opportunity to discuss proposed nominations. The Nominating Committee meets before February 1, and a list of nominees is published in *Electrical Engineering* in March. There is approximately a 30-per-cent return on the ballots and the cost is less than 0.2 of 1 per cent of the total annual Institute expenditures, or approximately $2,000. A motion was made and seconded to the effect that the Board of Directors be asked to re-examine Section 33, Article VI, of the Constitution on election of officers, but the motion was not carried.

SECRETARY HIBSHMAN'S MESSAGE

Secretary Hibshman was introduced and discussed "This is Your Institute," certificates for past Section chairmen, and technical conferences.

Regarding the illustrated lecture and data, "This is Your Institute," Secretary Hibshman said that, based on reactions obtained last year, the number of slides would be decreased from 20 to 10 and a package and data would be sent out in August enabling delegates to report on this meeting. He called attention to the information and data in the "Report of the Board of Directors" and extra copies were made available for the delegates. The Secretary urged that requests for certificates for past Section chairmen be sent in early with the dates of service so that the chairmen can receive them. In the fall or winter, it is deemed advisable to allow 1 month to 6 weeks; but for a spring meeting, it is better to allow 2 months as the engravers are busier then. The certificates are free but lapel buttons must be purchased by the Sections; there is no provision for honoring Subsection chairmen.

Special technical conferences were described by the Secretary as a growing dynamic part of Institute programs which the Sections find very desirable to hold in cooperation with a technical committee. These conferences are on a single subject appropriate for the region in which they are held. A complete manual on the procedure and arrangements is available, and those planning to sponsor conferences should be sure to get in touch early with R. S. Gardner, Assistant Secretary of the Committee on Technical Operations.

Vice-Chairman Bradley Cozzens called attention to the Section manual and the responsibility of getting the information to successors in the Sections.

AFFILIATE MEMBER REPRESENTATIONS

Vice-President Morton drew attention to Affiliate Member representation and the conference voted unanimously that Affiliate Members should have full voting power to represent the Sections.

QUESTIONNAIRE ON EMPLOYMENT CONDITIONS

Past-President F. O. McMillan said that this question had been before the engineering societies for some time anticipating that the Congress may revise the Taft-Hartley Act. Engineers Joint Council (EJC) felt that it was desirable to find out the thinking of members of the various societies on this subject, and the Board of Directors believes that the AIEE should prepare a similar survey of Institute members. A preliminary questionnaire was prepared and submitted to the Board of Directors, and a preliminary trial of the questionnaire was sent to the Lehigh Valley Section and yielded a 75-per-cent return. Based on the returns, the questionnaire was revised and resubmitted to the Board of Directors, which has referred the matter to the Executive Committee to review. If it should be decided that there is to be a questionnaire, it will be sent out in the fall and it was also decided material relative to the matter should appear in the August and September issues of *Electrical Engineering*. It is up to the chairmen of the Sections to see that the questionnaires are properly completed because considerable expense ($6,000) is involved and all efforts should be made to have the questionnaire filled in carefully.

REMARKS BY PRESIDENT ROBERTSON

President Robertson commented briefly on redistricting, a new engineering societies building, and unity of the profession. He pointed out that the Board of Directors has an anxious desire to operate the Institute in accordance with the wishes of the membership, and that the matter of redistricting is important so that Vice-Presidents through their contact from the Board of Directors can carry communications to all the Sections.

With reference to a new engineering societies building, President Robertson explained that a Committee of Presidents of Five Societies has been organized to expedite decisions of the boards of directors of the five societies. The committee is not soliciting any further locations for an engineering center, and Mr. Robertson expressed the hope that some day there would be an engineering societies building that would meet the wishes of a great majority of American engineering societies.

With regard to unity of the engineering profession, the president maintained that if unity were an engineering problem it would have been solved long ago. However, this is not an engineering problem but one in human relations. The Institute operates a little differently from some of the other societies in that its Executive Committee acts by letter-ballot on recommendations received from the Membership Committee

between Board meetings. An executive committee, no matter how good, cannot have a viewpoint and geographical diversification that comes from full board meetings five times a year. In conclusion, he said that the Sections are a very important part of the Institute. Although some say membership, and others say publications, one is indispensable to the other and the Sections play a very important part. Recent conferrence of the doctor's degree on President Robertson by Southern Methodist University was considered not only recognition of him, but recognition of the AIEE and the electrical engineering profession.

NEW SECTIONS AND CHANGES IN SECTION TERRITORY

Announcement was made that additional counties of Dauphin, Cumberland, Perry, Juniata, Miffland, and Lebanon were transferred from the Lehigh Valley Section to the Susquehanna Section established in June 1953. The New Hampshire Section was established as the 100th Section as approved by the Board of Directors last September.

The conference recommended the establishment of the following new Sections: 1. West Michigan Section; 2. Lima Section; 3. Hawaiian Section; 4. Iowa-Illinois Section; 5. St. Maurice Valley Section. It was also announced that eight new Subsections had been created, making a total of 60 Subsections.

SECTION GROWTH AWARDS

Section growth awards consisting of a gavel for first prize and a certificate for second prize were presented by Vice-President-Elect J. P. Neubauer. In the class of smaller-than-average Sections, South Carolina was first and West Tennessee second. In the class of larger-than-average Sections, Michigan was first and Lehigh Valley second.

PRIZE RULES FOR AIEE PAPERS

Proposed revised prize rules for AIEE papers were outlined by E. I. Green, chairman of the Committee on Award of Institute Prizes. The delegate from the Schenectady Section pointed out that there is a low usage of prizes in the Sections and that they neither stimulate enough good papers nor offer proper encouragement to the younger members. These views were supported by the delegate from the Seattle Section who reported that only 15 per cent of the prize money was used. The conference voted that the Committee on Award of Institute Prizes be requested to review the prize rules for AIEE technical papers for the purpose of establishing an effective competition among younger members.

STUDENT ACTIVITIES

As to ways in which the Sections might help student activities, R. F. Danner, chairman of the Committee on Student Branches, suggested that they might work out inspection trips, have a Section member act as father at a Father and Son Banquet, arrange to subsidize the price of tickets for one or more students, and establish a prize contest with prizes provided by the Sections. In conclusion, he stated that the Branches do not want to be dominated or managed by the Sections.

Chairman Lewis urged that the delegates go back and work with the Student Branches as much as possible and then work through the Membership Committees to see that the students become members after graduation.

PUBLICITY SERVICES

Attention was drawn to the section devoted to publicity in the "Section Activities" booklet by R. T. Ferris, chairman of the Public Relations Committee. However, while this section is helpful, it is not complete. The publicity representative, Raymond C. Mayer, has developed a 5-series radio script 13 minutes long intended for Section publicity committees to use over local radio stations. Mr. Ferris emphasized the importance of having strong publicity committees in the Sections. When the chairmen of publicity committees are appointed, Institute headquarters should be

Milwaukee Section Honors Past Chairmen

The AIEE Milwaukee Section held its Past Chairmen's Night and dinner-meeting on June 2, 1954. Following an address by F. H. Roby on "Why an Engineering Education," the Section chairman, H. C. Brem, presented pins to each of the past chairmen of the Milwaukee Section. Past chairmen attending were, left to right: G. G. Post, W. F. Lent, J. A. Potts, K. L. Hansen, T. B. Jochem, C. P. Feldhausen, J. F. H. Douglas, F. J. Van Zeeland, E. H. Frederick, F. H. Roby (speaker), H. L. Van Valkenburg, L. Aicher, W. E. Crawford, C. H. Krueger, E. T. Sherwood, E. W. Seeger, R. R. Ranson, E. J. Limpel, Mr. Brem, W. Richter

Erie Section Honors Prize Paper Winners

At the annual paper presentation of the AIEE Erie Section, first prize was awarded to "An Electric Drive for Rotary Snow Plows" by A. H. Hoffer and R. E. Willhite of the General Electric Company. Left to right: G. R. McDonald, awards chairman, congratulates Mr. Hoffer; looking on are I. W. Lichtenfels, third place winner, and R. D. Charlton, second place winner

notified so that the Public Relations Committee can send them the necessary tools.

PRESIDENT MONTEITH'S COMMENTS

The conference was complimented by President A. C. Monteith on the excellence of the discussion and concern was expressed over one comment that he had heard to the effect that the organization was run by the "brass." In this respect, better communications must be established and the views of members are needed. Delegates were asked to take these thoughts back to the Sections.

President Monteith said, "Engineering is the backbone of the country," and everything must be done to encourage activities in the Sections and Branches. Regarding the view that technology is ahead of the times and should wait until other philosophies catch up, the president explained that we do not dare wait. As engineers we should get together and report to the public what engineering is doing, and this can be done much better through a unity organization.

MEMBERSHIP TRANSFERS

Attention was called to "A Guide to Transfers of Membership" by E. P. Yerkes, chairman of the Committee on Transfers. As the Institute is a national organization for the professional representation of its members, it can be of maximum value only if each member occupies the highest grade of membership for which abilities and accomplishments qualify him. Mr. Yerkes emphasized the fact that it is of prime importance that all questions on the membership application be answered in full and that professional experience should be so stated that it describes what the applicant has done. In the case of transfers to the Fellow grade, the statement should set forth the distinction attained by the applicant in his field of work. References should be chosen with great care so that they can supply constructive information about the applicant's career.

A check list distributed in the morning session for topics to be discussed in the afternoon session, resulted in subjects in the following order of preference: 1. joint AIEE–Institute of Radio Engineers membership; 2. Section–Student Branch relations; 3. grade transfers, attendance, and fellowship; and 4. Section meetings, technical groups, and inspection trips. Dickson Lewis, vice-chairman of the Sections Committee, concluded the meeting with an expression of appreciation to the Presidents, Vice-Presidents, and officers, Bradley Cozzens, and J. L. Fuller, the secretary.

Counselors and Vice-Presidents Meet to Discuss Student Branch Activities

An informal exploratory meeting of counselor delegates and Vice-Presidents was held on Monday afternoon with R. F. Danner, chairman of the Committee on Student Branches, presiding. Among the items discussed were meetings of the District committees on student activities, prize paper competitions and grading rules, counselor responsibilities and problems, records, statistics and reports, Student Branch organization and operation, visits by Vice-Presidents, District secretaries, and District chairmen to the Branches in their respective Districts, and the relation of District, Section, and national organization to the conduct of student activities.

By a showing of hands, it was generally agreed that it is desirable for the District committee on student activities to meet early in the fall to organize plans for the forthcoming year and it is desirable to send the counselors to the District Student Branch prize paper contest meetings in the spring.

Counselors also agreed that it would be desirable for the District committees on student activities to exchange minutes of their meetings.

Vice-President W. B. Morton described operations in District 2 where there are 28 Branches and E. T. B. Gross, chairman of the District 5 Committee on Student Activities, outlined their methods of operation in which they have a chairman, senior vice-chairman, and junior vice-chairman so that the chairman working up to the top always will have had the experience of the previous years. Mr. Morton suggested that a better job of selling the Institute to students should be done and another suggestion was made to the effect that Student Branches should be subsidized as, for example, if a Section holds a dinner to which Student members are invited, each student's expenses might be paid by a member.

In respect to the publication of news on Student Branch activities in *Electrical Engineering*, the editor thanked those who have sent in news on activities. The flow of this material is very irregular but in the July issue there were about $4^1/_2$ pages of student activities because most of the Districts had recently held student prize paper competitions which they reported.

The reporting of news items promptly was strongly urged as it does little good to publish in June activities which took place in January and February. The editor pointed out ways in which to make news items of activities more newsworthy. Most of the Branches are doing the same things—taking field trips, having social get-togethers, and inviting guest speakers. For example, it is not enough to say that a trip was taken on a certain date to such and such a plant. If a trip was taken to a new plant where a feedback control system had recently been installed and the automation brought about an increase in production with less labor, that would be news.

One of the counselors present expressed the view that the news of Student Branch activities should be segregated to enable those interested to find it quickly. President Robertson strongly advocated that the student news should not be segregated but the students should be treated as part of the AIEE membership. If student news is interspersed with news of other activities, the prestige of the Student Branches will be enhanced, he feels.

District 5 Students Hold Conference and Paper Contest

The meeting of the Great Lakes District Committee on Student Activities and the competition of undergraduate and graduate student papers, presented by the Student Branches in AIEE District 5, was held May 14–15, 1954, in the Memorial Union Building on the campus of the North Dakota State College at Fargo. The meeting was highlighted by a banquet held on Friday evening, May 14, which was attended by 125 students and members, including the chairmen and counselors of all the Branches in the District, as well as members of the Red River Valley Subsection. R. N. Faiman, counselor of the Student Branch at the North Dakota State College, acted as toastmaster introducing R. M. Dolve, dean of engineering, North Dakota State College, for a welcome to the campus, as well as other District and Division officers including Chairman J. S. Love, of the Red River Valley Subsection, and Dr. Eric T. B. Gross, chairman of the Great Lakes District Committee on Student Activities and chairman of the conference. The main speaker at the banquet was Professor W. L. Cassell, Vice-President, District 5.

In his talk, Vice-President Cassell outlined the objectives of one of the colleges in the Great Lakes District, in the following areas of student attainment upon graduation: 1. vocational competence; 2. personal development; 3. social and civic responsibilities; 4. human relationships. Vice-President Cassell pointed out the usual student interest in vocational competence, to the possible disadvantage of the engineering profession because of disinterest in the other areas. He emphasized the importance of continued study in the humanities and in the social sciences, in one's everyday reading after graduation.

During the meeting of the counselors of the District, the following were elected officers for the next year: E. L. Fairchild, Wayne University, chairman; R. J. Ungrodt, Milwaukee School of Engineering, senior vice-chairman; R. D. Strum, Rose Polytechnic Institute, junior vice-chairman. Activities in District 5 are guided by the Officers Committee of three (the chairman and senior and junior vice-chairmen) under the provision that the junior vice-chairman will automatically move up into the position of senior vice-chairman and finally, during his third year of tenure, to chairman.

During this conference, three meetings of the chairmen of the Student Branches were held, presided over by J. R. White, chairman of the Branch at Illinois Institute of Technology. An early morning conference on Friday, May 14, was used as a get-acquainted period and for the formulation of particular matters to be discussed in the evening meeting on the same day and in another meeting on Saturday morning, May 15. These meetings proved to be very beneficial to the incoming chairmen of the Student Branches for guidance in their operations in the coming year.

Each of the 20 Branches in the Great Lakes District participated with an undergraduate paper in the competition for the District Branch cash prizes which are provided by headquarters (first prize) and by the Sections in the District (second and third prize).

It was the first time since the reactivation of District paper competitions in 1946 that all 20 Branches contributed an undergraduate paper. In addition to prizes for undergraduate papers, the Sections in the District also made available two cash awards for graduate papers. Participants in the graduate competition were from the Branches at universities with graduate schools and a large number of graduate students in the field of electrical engineering. The presentation of undergraduate papers took place in one morning and two afternoon sessions on Friday, and the presentation of the graduate papers in one morning session on Saturday.

A joint meeting of Branch chairmen and counselors was held on Saturday morning and those participating heard the reports from all Branches and discussed many questions of interest to Branch operations. The terminating affair was a luncheon presided over by Dr. Gross, during which Vice-President Cassell awarded the cash prizes to the following winners for their respective papers:

Undergraduate

First: "Piezoelectric Ceramics in High Fidelity," H. A. Johnson, Illinois Institute of Technology

Second: "Applications of the Digital Computer to the Design of Transient Amplifiers," R. W. Potter, University of Illinois

Third: "A Production Method of Metallurgical Analysis," J. D. St. John, Milwaukee School of Engineering

Graduate

First: "Analysis of a Traveling-Wave Tube With Transverse Current Components," A. G. Martorell, Illinois Institute of Technology

Second: "A New Microwave Detector," Gene Strull, Northwestern Technological Institute

The 1955 conference and Branch papers competition will be held next year in May at Marquette University in Milwaukee, Wis.

Fall Meeting Will Feature Broad Technical Program

The AIEE Fall General Meeting for 1954 will be held in Chicago, Ill., October 11–15, at the Morrison Hotel. In addition to a broad technical program covering power, science and electronics, industry, and general applications, the meeting will feature interesting inspection trips and social events.

Chicago is the center of one of the greatest diversified industrial areas in the world, and a number of inspection trips are being planned.

The visit to the Republic Steel Company plant will provide an opportunity to see the complete steel-making operation in a single plant. Republic is the world's largest producer of electric furnace steel, about one half of which is made in nine furnaces at the Chicago plant. This plant is one of the largest users of Commonwealth Edison power.

The Rauland Corporation plant is of interest in that it has facilities for the mass production of television tubes, as well as

Philadelphia Section Records Broadcast

The Radio Program Committee of the AIEE Philadelphia Section completed its first full season of weekly broadcasts on June 30, 1954, with the recording of two programs on "The Engineer in Steel." Seated, left to right: Aaron Howry, Daniel Bailey, and Thomas Williams, all of the Alan Wood Steel Company. Standing, M. L. Stoughton, I-T-E Circuit Breaker Company, chairman of the committee

Ridgway Section Holds Annual Dinner

District 2 Vice-President W. B. Morton was the featured speaker at the annual dinner-meeting of the AIEE Ridgway Section. His topic, "Light Begins at 80," covered the progress of electrical engineering. In the foregound of the picture Mr. Morton (left) congratulates the first-prize winner of the Section's 1954 paper competition, Dr. Mostafa E. Talaat. In the background, left to right: H. A. White, publicity chairman; W. P. Van Vranken, Section chairman; C. E. Sassman, secretary-treasurer; W. E. Yohe, membership committee; J. H. Schneider, vocational guidance chairman. Announced as officers for the new year were the vice-chairman, L. F. Simbeck, as chairman; Mr. Sassman as vice-chairman; and Mr. Yohe, secretary-treasurer

Aerial view of the Chicago plant of the Republic Steel Corporation, to be visited during the Fall General Meeting

many other special tubes and advanced electronic equipment.

The Delta Star Electric Division of H. K. Porter Company, which will be visited, is a manufacturer of high-voltage electric switching equipment, heavy-duty metal-enclosed bus runs, outdoor substations, and allied equipment.

Ridgeland Station is the Commonwealth Edison Company's newest and most modern generating station. Here will be seen the new and highly efficient cyclone furnaces, four on each boiler, which together consume 750 tons of coal daily.

Motorola, Inc., the world's largest manufacturer of automobile radio equipment and producer of television receivers, microwave systems, and other electronic equipment, will be inspected also, as will be the Hawthorne plant, oldest of the Western Electric Company manufacturing plants. It is estimated that over half of the 75 million telephones in the world today were made at Hawthorne.

At the Institutes for Basic Research of the University of Chicago, which include the Institute for Nuclear Studies and the Institute for the Study of Metals, visiting members will see among other things, the 450-megelectron-volt cyclotron, the 100-megelectron-volt betatron, and the low-temperature laboratory.

HOTEL RESERVATIONS

The week of October 11 will be a big convention week in Chicago and hotels will be crowded. The Hotel Arrangements Committee, therefore, urges that those planning to attend the Fall General Meeting send their requests for hotel reservations in early.

Hotel room reservations requests should be sent to Convention Department, Morrison Hotel, Madison and Clark Streets, Chicago 2, Ill., or to the hotel selected. AIEE should be mentioned in the request, and a copy sent to G. L. Welch, Hotel Arrangements Committee, in care of Westinghouse Electric Corporation, Merchandise Mart, Chicago 54, Ill.

Rates per day at the Morrison Hotel are

Single room (one person)	$ 5.50 to $12.00
Double room—double bed (2 persons)	9.00 to 16.00
Double room—twin beds (2 persons)	11.50 to 16.00
Suites—parlor, bedroom (double bed)	18.00 and 22.00
Suites—parlor, bedroom (twin beds)	27.00 to 37.00

Inspection Trips Announced for Middle Eastern Meeting

The heart of the "Pennsylvania Dutch" region, Reading, Pa., will be the location for the AIEE Middle Eastern District Meeting, October 5–7. Meeting headquarters will be at the Abraham Lincoln Hotel.

The District 2 Executive Committee will meet on Monday, October 4, in the Abraham Lincoln Hotel. The opening general session will take place Tuesday, October 5, at 10:00 a.m. The formal opening will be highlighted by a keynote speech.

There will be a total of 21 technical sessions covering textiles, industrials, steel, mining and quarrying, power, substations, relays, microwave, telemetering and supervisory control, transmission and distribution, communication and television, safety and fire protection, atomic energy, and miscellaneous subjects.

Inspection trips have been scheduled to the Titus Station, Textile Machine Works, Beryllium Plant, Carpenter Steel Company, and the new Metropolitan Edison Company office. The Textile Machine Works is the largest of its kind in the world. In addition, sight-seeing tours of local historic places and points of interest will include the famous furnaces of Hopewell Park where cannons for Revolutionary guns were made; the birthplace of Daniel Boone; the Pagoda of unusual Japanese architecture; and the uhf tower of station *WHUM*, the second uhf station in the United States to televise commercial broadcasts. This tower is 1,036 feet high.

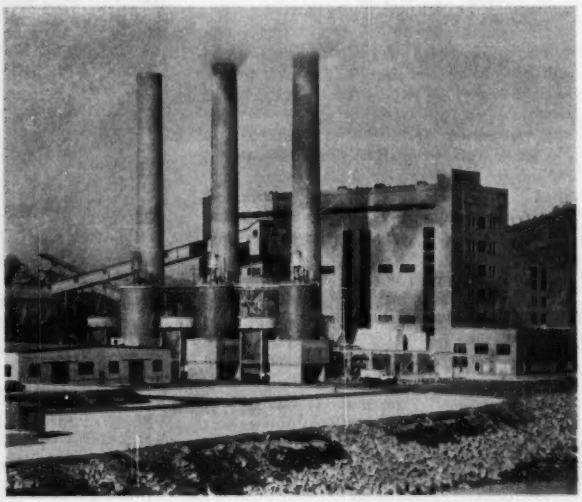
The Ladies Committee has arranged a busy and interesting program for each day of the meeting. One of the highlights will be a trip to Hershey, Pa., with a visit to the museum, luncheon at the Hershey Hotel, and a visit to the Hershey Chocolate Company Plant.

On Tuesday a "Fersommling" will be held for men and ladies. This is a Pennsylvania Dutch smorgasbord smoker. The dinner-dance will be held on Wednesday evening, informal dress, in the Abraham Lincoln Hotel Ballroom. Luncheon schedules are as follows: Executive Committee, Monday; General Meeting, Tuesday; Students Meeting and Textile Subcommittee Meeting, Wednesday.

Sports arrangements can be made for golf, tennis, and horseback riding.

Reservations for hotel accommodations and other reservations should be made immediately upon receiving the necessary cards. Accommodations will be made by the Abraham Lincoln Hotel.

Reading can be reached by rail, highway, or air. The Reading Railroad serves Reading, and air service is available at the Reading Municipal Airport. Access by bus or automobile is possible from all directions; two points of entrance to the Pennsylvania Turnpike are within 16 miles of the city of Reading.



One of six generating stations of Metropolitan Edison Company is the Titus Station on the west bank of the Schuylkill River, which will be inspected during the Middle Eastern District Meeting. This station has a capacity of 240,000 kw in three 80,000-kw units

Petroleum Committee to Hold First Technical Conference

The newly formed AIEE Petroleum Committee will sponsor its first technical conference in Tulsa, Okla., September 27–29, 1954, at the Mayo Hotel. A broad industry-wide coverage of production, refining, and transportation of oil, gas, and petro-chemicals has been reflected in the 19 papers selected.

All the conference papers will be aimed at advancing the art and technology of electrical engineering within the petroleum industry. Advance copies will not be available except to those persons desiring to discuss a paper, who should contact W. H. Stueve, 320 Oklahoma Natural Building, Oklahoma City 2, Okla.

A joint luncheon with the Tulsa Engineers Club is planned for Monday, September 27, with Governor Johnston Murray of Oklahoma as speaker. Speaker at the stag banquet on Tuesday evening is scheduled to be AIEE President A. C. Monteith. Inspection trips are planned for Wednesday afternoon.

An important meeting of the Petroleum Committee will be called on Wednesday afternoon by Chairman J. Z. Linsenmeyer to plan the next technical conference and to study ways and means to give more recognition to the needs of electrical engineers within the petroleum industry and further advance the art and technology.

For hotel reservations, pre-registration forms, and complete listing of the papers write M. C. Callahan, Gulf Refining Corporation, Northern Pipe Line Division, P. O. Box 661, Tulsa 2, Okla. Registration fee is $3.00, payable in advance or at the time of registration. Checks should be made payable to Dale H. Watt, Treasurer, "Electrical Conference of the Petroleum Industry."

January Meeting Scheduled on High-Frequency Measurements

The fourth meeting of the Conference on High-Frequency Measurements will be held on January 17–19, 1955, in Washington, D.C. This meeting which has become a biennial affair presents the latest advances in the art of radio measurements. The 1955 meeting will be sponsored by AIEE, the Institute of Radio Engineers, the International Scientific Radio Union, and the National Bureau of Standards.

Papers are solicited for the following four sessions of this meeting and 100-word abstracts should be sent to the indicated session chairman before September 30, 1954.

1. Frequency and Time Measurements
Dr. B. M. Oliver, Hewlett-Packard Company, Palo Alto, Calif.

2. Power and Attenuation Measurements
E. W. Houghton, Bell Telephone Laboratories, Murray Hill, N. J.

3. Impedance Measurements
Dr. D. D. King, Johns Hopkins University, Baltimore, Md.

4. Measurements in Transmission and Reception
B. Parzen, Olympic Television and Radio Company, Long Island City, N.Y.

Memphis Section Officers for 1954-55

At the last meeting of the AIEE Memphis Section for the current year, election of officers for the 1954–55 term took place. Left to right: Past Chairman W. C. Jordan, Jr., welcomes the incoming officers, John Thrithart, chairman; M. H. Parnell, treasurer; and Ci Young, secretary

Eastern Computer Conference to Be Held in Philadelphia

The fourth annual Eastern Joint Computer Conference and Exhibition will be held in the Bellevue-Stratford Hotel, Philadelphia, Pa., December 8–10, 1954. The theme of the conference, which is jointly sponsored by the AIEE, the Institute of Radio Engineers, and the Association for Computing Machinery, will be "Design and Application of Small Digital Computers."

Latest products of more than 60 companies in the computer field will be exhibited during the conference. Conducted tours to computer manufacturers and installations in the Philadelphia area are planned.

Information on registration, which is open to all, may be obtained by writing Eastern Joint Computer Conference, P. O. Box 7825, Philadelphia 1, Pa.

Geologist Addresses Meeting of Royal Sorensen Fellows

Dr. Robert P. Sharp, professor of geology and head of the Division of Geology at the California Institute of Technology, was the featured speaker at the recent dinner-meeting of "The Royal W. Sorensen Fellows" of the AIEE. Dr. Sharp's address, which was entitled "The Ice Man Cometh," was illustrated by colored pictures taken by Dr. Sharp who has spent a number of summers in the glacial area near the North Pole studying the characteristics of the glaciers of that area.

The organization, which meets annually, will continue during another year, having elected a new chairman, J. M. Gaylord, and a new vice-chairman secretary, H. L. Caldwell. President for the current year was F. H. Cole and Mr. Gaylord was vice-chairman secretary. Dr. Sorensen is honorary president of the group.

Subsection Is Formed for Southern Colorado

On June 5, 1954, a group of members of the AIEE Denver Section met in Pueblo, Colo., in response to a request from members in the area to establish a Southern Colorado Subsection of the Institute. G. F. Wallis was elected chairman of the new Subsection and G. D. Perry, Jr., secretary-treasurer.

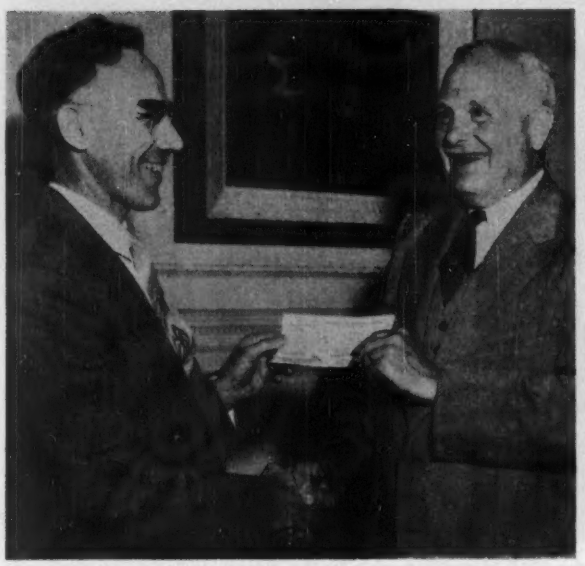
The Denver Section group consisted of A. S. Anderson, Vice-President, District 6; John Martin, secretary-treasurer, District 6; Chairman H. F. Gidlund and Secretary-Treasurer A. E. Paige of the Denver Section; and three other members of the Executive Committee.

The meeting was preceded by dinner, after which Mr. Anderson discussed the AIEE activities and procedures.

Hamilton Section Forms Subsection at London, Ont.

On March 31, 1954, at a meeting held at the University of Western Ontario, 14 members of AIEE and 19 visitors met to organize a London Subsection of the AIEE Hamilton (Ont., Canada) Section. The new

Montreal Prize Paper Award



At the recent annual dinner meeting of the AIEE Montreal Section, R. B. Hickes received an award from G. D. Floyd (right), Vice-President, District 10. Mr. Hickes and R. B. Reed of the Shawinigan Water and Power Company were co-authors of a paper on single-pole reclosing which was judged the year's best

Subsection will include the counties of Huron, Perth, Oxford, Elgin, Middlesex, and Norfolk.

At this organization meeting, at which G. D. Floyd, Vice-President, District 10, was present, the following officers were elected: D. N. Culver, chairman; R. M. Laurie, vice-chairman; L. P. Atkins, secretary-treasurer; T. H. Lewis, program chairman; W. H. Hopper, membership chairman; F. Macenko and N. Meikle, members-at-large of the Executive Committee.

Following the election of officers, two films outlining two hydroelectric power developments were shown through the courtesy of the Hydro-Electric Power Commission of Ontario.

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Note. Because of the changeover in committee personnel, no items on committee activities are included in this issue.

AIEE PERSONALITIES.....

James Harold Foote (AM '18, M '29, F '32), vice-president, Commonwealth Services, Inc., New York, N. Y., and president and chief engineer in charge of its subsidiary, Commonwealth Associates, Inc., Jackson, Mich., has been elected a Director of the AIEE to fill the term of N. C. Pearcy, who has resigned. Mr. Foote was born in Jackson, Mich., November 21, 1891, and was graduated from Michigan State College in 1914. Since 1915 he has been associated with affiliated companies now forming Commonwealth Services, Inc. In various capacities he has been responsible for the design and construction of power distribution systems for the Eastern Michigan Power Corporation, Consumers Power Company, Stevens and Wood, Inc., Allied Engineers, and Commonwealth and Southern Corporation, all in Jackson. In 1931 he was made supervising engineer for Commonwealth and Southern, and in 1950 was elected vice-president of its successor, Commonwealth Services, Inc., and president and chief engineer of its engineering subsidiary, Commonwealth Associates. Mr. Foote has served on the board of directors of the American Society for Testing Materials and on the Standards Council of the American Standards Association. He is a member of the Edison Electric Institute's Electrical Equipment Committee and the Committee on Electric Switching and Switchgear of the Association of Edison Illuminating Companies. He is a registered professional engineer in several states and is active in the affairs of the National Society of Professional Engineers. He is a past president of the Michigan Engineering Society and has served on the Michigan State Board of Registration of Architects, Professional Engineers, and Land Surveyors. He is a member of the American Association for the Advancement of Science, the American Society for Engineering Education, Tau Beta Pi, Eta Kappa Nu, and Pi Tau Sigma. He has served on the following AIEE committees: Power Transmission and Distribution (1929–31); Protective Devices (1932–34); Power Generation (1936–46); Domestic and Commercial Applications (1940–41); Registration of Engineers (1946–54); Standards (1947–50); Insulated Conductors (1947–49); and Liaison Representative on the Standards Committee (1951–54).

A. E. Silver (AM '07, F '26, Member for Life), retired, Ebasco Services, Inc., New York, N. Y., has been awarded an honorary doctor of engineering degree by the University of Maine "in recognition of leadership and outstanding accomplishments" in his chosen profession. Dr. Silver was born in Dexter, Maine, on August 14, 1879, and was graduated from the University of Maine in 1902 with a bachelor of science degree in electrical engineering. Following graduation he spent 2 years in the expert electrical course, testing department, General Electric Company, Schenectady, N. Y. In 1904 he entered the employ of the Raleigh (N. C.) Electric Company, in charge of the meter department. He was made electrical superintendent and chief engineer of the Carolina Power and Light Company in 1906 and held this position until 1910. Dr Silver then became associated with the engineering department, Electric Bond and Share Company, New York, N. Y., and in 1919 he was made consulting electrical engineer in charge of all electrical engineering problems. In 1935 the service activities of the Electric Bond and Share Company for clients was transferred to a newly organized subsidiary, Ebasco Services, Inc., and he continued with this company as consulting engineer until his retirement in 1948. He is retained by Ebasco Services as associate consultant for advisory contacts. Dr. Silver was awarded the AIEE Lamme Medal for 1951 "for his pioneering of rural electrification by designing the simplified farm-type transformer combined with high voltage, long span, and common neutral line construction." He has been active since 1915 in the work of the technical committees of the National Electric Light Association and its successor, the Edison Electric Institute, and is a member of the American Association for the Advancement of Science. He has served on the following AIEE committees: Telegraphy and Telephony (1920–22); Power Transmission and Distribution (1918–22, 1924–49); and Power Generation (1929–39).

Elgin B. Robertson (M '24, F '45), president, Elgin B. Robertson, Inc., Dallas, Tex., was awarded the honorary degree of doctor of engineering by the Southern Methodist University. Past president of the AIEE, Mr. Robertson was honored as an "electrical engineer, designer of electrical equipment, manufacturer and industrial executive who has received national acclaim for his leadership in the advancement of engineering as a profession." He was particularly cited for his part in trying to make engineering a true profession. Mr. Robertson, who also is president of Plastics Manufacturing Com-

pany, Dallas, is a native of Meriden, Tex., and received his degree in electrical engineering from the University of Texas in 1915. Prior to forming his own company in 1928, Mr. Robertson was connected with Westinghouse Electric and Manufacturing Company (now Westinghouse Electric Corporation), and the Railway and Industrial Engineering Company, Greensburg, Pa. During World War II he served on the War Production Board as production engineer in 1942 and later was named regional utility engineer and regional manager of the production department. Mr. Robertson has been president of the Institute (1953–54) and director (1947–51, 1951–53), and has served on the following AIEE committees: Membership (1944–46); Board of Directors (1947–54); General Applications Division (1947–51); Registration of Engineers (1946–52, Chairman, 1949–51); Planning and Co-ordination (1946–53, Chairman, 1952–53); Professional Division Advisory (1949–51); Lamme Medal (1951–54); Edison Medal (1952–54); and Executive (1952–54, Chairman, 1953–54).

James Harold Foote

A. E. Silver

Elgin B. Robertson

R. E. Shelby (AM '36, F '51), director, color television systems development, National Broadcasting Company (NBC), New York, N. Y., has been elected vice-president and chief engineer of the company. Born in Austin, Tex., on July 20, 1906, Mr. Shelby was graduated from the University of Texas, where he received the degrees of bachelor of science in electrical engineering, bachelor of arts, and master of arts. He went to work for NBC in 1929. When NBC first established its television development laboratory in the Empire State Building in New York City in 1931, he was placed in charge of the project, supervising the earliest experimental work in television operation techniques. From 1935 to 1937 he assisted in the organization of field tests of all-electronic television and in the design of equipment and facilities for those tests. During World War II, Mr. Shelby directed NBC's wartime research and development activities. He also served during this period as technical consultant to the National Defense Research Committee. Among the other executive positions he has held in the NBC engineering department are director of technical development, director of technical operations for the television network, and director of color television systems development. He has participated in the work of the National Television System Committee, the Radio Technical Planning Board, and the Radio-Electronics-Television Manufacturers Association. Mr. Shelby is a fellow of the Institute of Radio Engineers and a member of the Society of Motion Picture and Television Engineers, Tau Beta Pi, Phi Beta Kappa, Eta Kappa Nu, and Sigma Xi. He has served on the AIEE Committees on Communication (1946–49) and Television and Aural Broadcasting Systems (1949–54).

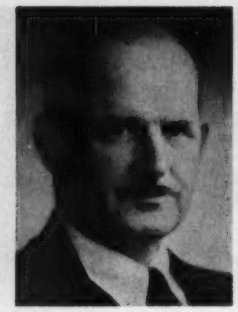
J. F. Calvert (AM '27, F '45), chairman, electrical engineering department, Northwestern University, Evanston, Ill., has been named head of the electrical engineering department at the University of Pittsburgh, Pa., effective August 1, 1954. Dr. Calvert is a graduate of the University of Missouri, having received his bachelor of science degree in 1922 and the electrical engineer degree in 1924. He received his masters degree in 1930 and his doctor of philosophy degree in 1936 from the University of Pittsburgh. From 1924 to 1936 he was with Westinghouse Electric and Manufacturing Company (now Westinghouse Electric Corporation) as a design and development engineer. From 1936 to 1938 he was an associate professor at Iowa State College, Ames, and served the Iowa State Planning Board as a consultant on proposed rural electrification projects. Since 1938 he has been a professor and since 1939 a professor and chairman of the electrical engineering department at Northwestern University. On leave with the Naval Ordnance Laboratory for 1941–42, he was in charge of the design and represented the laboratory on the construction of the Pacific Magnetic Proving Grounds in Hawaii. In 1942 he organized and directed the Naval Radio Training School at Northwestern and assisted in the organization of a preradar school. In 1943 he organized and directed a weapons research project. In 1944 he organized a research group which was engaged on problems for the Navy Bureau of Aeronautics. The latter group led to the organization of the Aerial Measurements Laboratory which has continued under Dr. Calvert's direction. Dr. Calvert is a senior member of the Institute of Radio Engineers and is a member of the Illinois Engineering Council, American Society for Engineering Education, Western Society of Engineers, and the National Electronics Conference, as well as Tau Beta Pi, Eta Kappa Nu, and Sigma Xi. He is a past chairman of the Washington Award Commission and has served as chairman of the Chicago Section of the AIEE (1945–46) and as chairman of the Institute Committees on Student Branches (1948–49) and Edison Medal (1951–53) and as vice-chairman of the Committee on Electrical Machinery (1942–46).

J. D. Webster (AM '46), sales engineer, General Electric Company, San Francisco, Calif., has been transferred to the X-ray department, Milwaukee, Wis., as manager of industrial and nonallied sales. Since 1951 Mr. Webster has worked as sales engineer in the Apparatus Division industrial sales department in San Francisco. He was graduated from the University of California in 1941 with a bachelor of science degree in electrical engineering. Upon graduation he joined General Electric and after a short period in Schenectady, N. Y., was transferred to the engineering department in San Francisco. From 1943 to 1945 he worked under a General Electric assignment on the Manhattan atomic bomb project at the Radiation Laboratory of the University of California. In 1945 he transferred to electrical utility sales in San Francisco, and in 1950–51 was assigned to the Livermore project in connection with the Atomic Energy Commission.

B. M. Werly (AM '25, F '51), superintendent, construction and maintenance division, engineering and manufacturing services, Eastman Kodak Company, Rochester, N. Y., has been appointed assistant manager, engineering, construction, maintenance, and utilities organization of the company. After being graduated from Cornell University, Mr. Werly started at Kodak as an electrical engineer in the electrical department at Kodak Park in 1922. He was made electrical engineer in charge of plant electrical engineering, maintenance, and construction in 1928, and 2 years later became electrical engineer in charge of plant electrical engineering and electric power generation and distribution. In 1943 he transferred to Clinton Engineering Works, Tennessee Eastman, Oak Ridge, as superintendent of the electrical division. He became assistant manager of the division a year later, and the following year, manager. He returned to Kodak Park in 1947 and was appointed superintendent of construction and maintenance. Mr. Werly has served on the AIEE Committees on Industrial Power Applications (1940–43) and Electrical Machinery (1942–44).

T. J. Killian (AM '35), chief scientist, Office of Ordnance Research, U. S. Army, Durham, N. C., has been appointed dean of the School of Engineering and Architecture, Catholic University of America, Washington, D. C. He will begin his new duties in September 1954. Dr. Killian received his bachelors and masters degrees in electrical engineering at Massachusetts Institute of Technology and then did graduate study, majoring in physics at Princeton University, which awarded him the degree of master of arts in 1927 and doctor of philosophy in 1929. After obtaining his doctorate, Dr. Killian taught at Massachusetts Institute of Technology, Cambridge, and then was dean of mathematics at Seattle (Wash.) University until 1936. Since 1941 he has rendered outstanding service as an engineer and scientist to the U. S. Army and Navy. In the Navy he was

R. E. Shelby



J. F. Calvert

head of the physics section of the Naval Postgraduate School, Annapolis, Md. From 1947 to 1952 he served as science director in the Office of Naval Research. In 1952 he accepted the position he now holds as chief scientist, Office of Ordnance Research, U. S. Army. Dr. Killian is a fellow of the Institute of Radio Engineers, American Physical Society, and American Association for the Advancement of Science, and a member of the Illuminating Engineering Society, Operations Research Society of America, Tau Beta Pi, and Sigma Xi. He is serving on the AIEE Committee on Research (1949–54).

T. G. A. Sillers (AM '26, M '43), assistant chief engineer, switchgear department, Allis-Chalmers Manufacturing Company, West Allis, Wis., has been promoted to chief engineer of the department. He will continue to make his headquarters at the Hawley Works, West Allis. **J. F. Chipman** (AM '50), engineer-in-charge of circuit breaker design at the Boston Works, Hyde Park, Mass., has been appointed assistant chief engineer of the switchgear department. He will continue to be located at the Boston Works. Mr. Sillers has been associated with Allis-Chalmers switchgear operations in various engineering capacities since 1926 and holds a number of patents in this field. He has served on the AIEE Committees on Transmission and Distribution (1947–48) and Switchgear (1953–54). Mr. Chipman joined Allis-Chalmers Boston Works in 1936 and has held the positions of assistant division engineer, division engineer, assistant product engineer, and product engineer of the circuit breaker section. He holds various switchgear equipment patents.

L. J. Linde (AM '39, F '51), assistant general manager and chief engineer, Boston Works, Allis-Chalmers Manufacturing Company, Hyde Park, Mass., has been named director of electrical engineering for the General Machinery Division. Mr. Linde, before his appointment in 1951 as assistant general manager and chief engineer of the Boston Works, was retained by contract as a consulting engineer. From 1945 to 1950 he was chief engineer for the A. B. Chance Company, Centralia, Mo., where he designed and built a mobile short-circuit testing laboratory. For 16 years prior to that he was associated with the General Electric Company's power circuit breaker department. In 1941 he was named assistant to the managing engineer and was in charge of engineering of that department. Mr. Linde holds many patents in the switchgear and allied fields. He is a member of The American Society of Mechanical Engineers, the Institution of Electrical Engineers (Great Britain), and the International Conference on High-Voltage Research.

C. H. Lang (AM '43), vice-president in charge of public relations General Electric Company, Schenectady, N. Y., has been awarded an honorary doctor of law degree by Union College. A native of Erie, Pa., Mr. Lang was graduated from the University of Michigan in 1915 with a bachelor of arts degree. After a year's overseas service in World War I as a lieutenant, he joined General Electric as a traveling auditor. In 1922 he became assistant manager of the publicity department at Schenectady, N. Y. Four years later he was appointed comptroller of the budget for the company. In 1932 he became advertising manager of the publicity department and manager of broadcasting. He later organized a Market Research Division. In 1940 Mr. Lang became manager of sales, apparatus department, and the following year was elected a vice-president. He was named to his present position in 1951.

A. F. Edel (M '37), assistant electrical engineer, Pennsylvania Power and Light Company, Allentown, retired April 30, 1954. Mr. Edel was born in Richmond, Va., April 19, 1889. A graduate of the University of Virginia in 1912, where he received degrees in mechanical and electrical engineering, Mr. Edel also took graduate subjects at Cornell and Lehigh Universities and completed several special courses while with the U. S. Navy. Mr. Edel served with Stone and Webster Company from 1912 to 1914. He worked for Western Electric Company until May 1, 1916, when he joined Electric Bond and Share Company, New York, N. Y. He served as a U. S. Naval officer from 1917 to 1919. Joining Pennsylvania Power and Light in 1921 as chief draftsman, Mr. Edel was promoted to engineer, electrical division, in May 1926. He took a leave of absence from Pennsylvania Power and Light in February 1941 to serve as an officer in the Navy during World War II. He retired from the Navy as a rear admiral. He returned to the company in April 1946 as assistant to electrical engineer and was promoted to assistant electrical engineer in September 1948.

Walter Evan-Jones (AM '46), Ontario sales supervisor, Canadian Marconi Company, Ont., Canada, has been named assistant sales supervisor of commercial radio communication equipment, Montreal, Que., Canada. Prior to joining Canadian Marconi in 1953, Mr. Evan-Jones was with the Canadian Comstock Company, Ltd., Frequency Conversion Division, St. Catharines, Ont., the Communications Group of the Hydro-Electric Power Commission of Ontario, and Northern Electric Company, Ltd. He has been engaged in the communication field for the past 12 years and is an associate member of the Institute of Radio Engineers.

L. W. Jones (AM '51), General Electric Company, Philadelphia, Pa., has been appointed regional manager for the Roller-Smith Corporation, Bethlehem, Pa. Mr. Jones received his bachelor of science degree in electrical engineering from Bucknell University.

E. W. Taylor (AM '20, M '31), generating station engineer, Pennsylvania Power and Light Company, Allentown, has been named station electrical engineer. **H. J. West** (AM '47), senior project engineer, has been named generating station engineer. Mr. Taylor, a native of York, Pa., was graduated from Pennsylvania State College in 1919 with a bachelor of science degree in electrical engineering. Mr. Taylor worked in the test department, General Electric Company, Schenectady, N. Y., in 1919, moving to the Newark, N. J., district office in 1920 as service engineer. For a short time in 1923 he worked for Public Service Production Company in Newark. Mr. Taylor joined Pennsylvania Power and Light in October 1923 as engineer assistant, becoming engineer in 1927, electrical coordinator in 1929, inspector in 1933, engineer—electrical section, 1935; assistant electrical engineer in 1942, and generating station engineer in 1945. Mr. Taylor is a member of the Pennsylvania Society of Professional Engineers, Engineers Club of the Lehigh Valley, Tau Beta Pi, Eta Kappa Nu, and Phi Kappa Phi. Mr. West is a native of Tamaqua, Pa., and a graduate of Pennsylvania State College where he received his bachelor of science degree in electrical engineering in 1934. He joined Pennsylvania Power and Light in 1934 at the Harwood steam electric station, becoming a junior engineer there in 1936 and results engineer in 1941. In 1943 he was promoted to supervisor of operations at Lykens plant. He moved to Allentown in 1945 as engineer—electrical station, subsequently being promoted to senior engineer in 1946, project engineer in 1950, and senior project engineer in 1952. He is a member of the Engineers Club of the Lehigh Valley.

N. H. Mageoch (AM '44), director of engineering and research, Instrument Division, Daystrom Incorporated, Archbald, Pa., has been named a vice-president of the company. Mr. Mageoch, a graduate of Drexel Institute, has been director of engineering and research at the instrument plant since 1951. He has a wide background in the engineering and manufacturing fields, having held executive positions with such firms as Atwater Kent,

General Electric, Philadelphia Electric, and Western Electric before joining Daystrom Instrument. He is a member of the American Ordnance Association, the Institute of Radio Engineers, and the Association for Computing Machinery.

J. S. Johnson (AM '37, M '43), assistant dean of engineering and professor of electrical engineering, University of Florida, Gainesville, has been named head of the school of electrical engineering at Purdue University, Lafayette, Ind., and will assume his duties August 1, 1954. Dr. Johnson was born in Grower, Mo., and attended the University of Missouri, receiving his bachelors degree in electrical engineering in 1932 and his masters degree in 1934. He then accepted a position as a graduate assistant at Iowa State College, Ames, where he continued his graduate work and earned the doctor of philosophy degree in electrical engineering in 1937. He served on the teaching and research staffs of Iowa State College, 1934–37; and at the Missouri School of Mines, Rolla, 1937–44, where in 1939 he was promoted to assistant professor of electrical engineering. In 1946 he was appointed associate professor of electrical engineering at the University of Florida and in 1947 he was promoted to professor of electrical engineering and also accepted the responsibilities of assistant dean of engineering. In addition to his regular teaching activities, he did extension instructional work during part of the war period. During World War II he attended Bowdoin and Massachusetts Institute of Technology Electronics and Radar Schools, and from 1944–46 with the rank of lieutenant served in the U. S. Navy as electronics officer. His industrial experience covers employment with Century Electric Company, General Electric Company, Westinghouse Electric Corporation, Florida Power Corporation, and the Florida Power and Light Company. Dr. Johnson is a member of the American Society for Engineering Education, the National Society of Professional Engineers, Tau Beta Pi, Sigma Xi, and Eta Kappa Nu.

A. E. Fernald (AM '41), television transmission engineer, New England Telephone and Telegraph Company, Boston, Mass., and **R. O. Schlegelmilch** (AM '46, M '51), electronics scientist, U. S. Air Force Rome Air Development Center, Rome, N. Y., have been awarded Sloan Fellowships for participation in the executive development program at Massachusetts Institute of Technology, Cambridge.

Fulton Cutting (M '17, Member for Life), assistant to the president, Stevens Institute of Technology, Hoboken, N. J., has been elected a member of the board of trustees of the college. Dr. Cutting has been coordinating the research activities of Stevens since 1947. Dr. Cutting is a graduate of Harvard University where he also earned the master of arts, the master of electrical engineering, and the doctor of science degrees. Dr. Cutting was a founder and chairman of the board of the Colonial Radio Corporation until it was merged with Sylvania Electric Company. During World War II he was a member of the operational research staff of the Office of the Chief Signal Officer. He is a past president of the Institute of Radio Engineers.

F. W. Bowden (AM '51), head of the electrical engineering department, California State Polytechnic College, San Luis Obispo, was one of the engineering faculty members selected to participate in the annual General Electric Company professors' conference in New York, N. Y., June 28 to July 29, 1954.

Woodman Perine (AM '35, M '47), associate director, Vitro Laboratories, Vitro Corporation of America, Silver Spring, Md., has been appointed assistant general manager of Vitro Laboratories and director of the Silver Spring laboratory. Mr. Perine has served as associate director of the Silver Spring laboratory since its establishment in 1948. Before joining Vitro he was a staff member of the Applied Physics Laboratory of Johns Hopkins University in Silver Spring. During World War II he served as director of field engineering for the war research division of Columbia University. Before the war he had 10 years of service as development engineer with Consolidated Edison Company of New York, Inc. Mr. Perine graduated from Rensselaer Polytechnic Institute in 1931 and is a member of the American Association for the Advancement of Science and Sigma Xi.

H. C. Koenig (AM '18, F '51), manager, Electrical Laboratory Services, and a member of the board of directors, Electrical Testing Laboratories, New York, N. Y., has been appointed chairman of the American Standards Committee on Electrical Measuring Instruments. Mr. Koenig has served with American Standards committees since 1926, the year after he became associated with Electrical Testing Laboratories. He has served on the following AIEE committees: Instruments and Measurements (1927–54, Chairman, 1936–39); Technical Program (1936–39); Standards (1953–54); and Liaison Representative on Standards (1951–53).

J. E. Casey (AM '47), field service engineer, Leeds and Northrup Company, Chicago, Ill., has been appointed regional service manager of the East-Central Region with headquarters in Cleveland, Ohio. After joining Leeds and Northrup in 1936 as an electrical instrument maker, Mr. Casey studied electrical engineering at Drexel Institute of Technology, graduating in 1941.

W. J. Maytham (M '49), Pacific Coast regional manager, Apparatus Divisions, Westinghouse Electric Corporation, San Francisco, Calif., and **O. O. Rae** (AM '26), Southeastern regional manager, Apparatus Divisions, Westinghouse Electric Corporation, Atlanta, Ga., have been elected vice-presidents of the company. Mr. Maytham has held various sales and executive posts with Westinghouse for the past 28 years. A native of Atlanta, Ga., he received his electrical engineering education at Iowa State College and joined Westinghouse in 1926 as a graduate student. After serving as an industrial salesman at Indianapolis, Ind., he was transferred to the company's mid-America regional headquarters at Chicago, Ill., in 1929 as manager of the petroleum and mining section of the Industrial Division. In 1944, he became industrial manager there, and in 1949 was transferred to San Francisco as Pacific Coast regional manager of the Apparatus Divisions. Mr. Rae has been with Westinghouse since 1919. A native of Augusta, Ga., he received his electrical engineering degree from Georgia Institute of Technology in 1918. After a brief period of service with the U. S. Army Engineers, he joined the company as a graduate student at East Pittsburgh, Pa. He was transferred to the Atlanta office in 1922 and was appointed electric utilities manager in 1934. He became regional manager for the Apparatus Divisions there in 1950.

F. W. Bush (AM '36, M '43), assistant manager, electrical sections, power department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been appointed assistant to the vice-president in charge of transformer and switchgear equipment. **R. O. Bell** (AM '37, M '47), special representative, power department, has been assigned to the transformer and switchgear organization to handle special assignments. Mr. Bush, who has been with Allis-Chalmers since 1928, was assistant manager in charge of the power department for the last 3 years. Prior to that he had been assistant manager of the electrical department for 5 years and before that sales engineer-in-charge of transformer sales. He is a member of the board of directors of the Engineers' Society of Milwaukee. Mr. Bell joined Allis-Chalmers in 1936 and was successively engineer-in-charge of transformer sales and manager of the substation section. From 1952 to 1953 he served as chief of the transformer section, Electrical Equipment Division, National Production Authority, Washington, D. C. Mr. Bush has served on the AIEE Committees on Management (1947–52) and Fortescue Fellowship (1949–52) and Mr. Bell has served on the Institute Committee on Substations (1948–53).

S. C. Killian (AM '42, M '46), chief engineer, Delta-Star Electric Division, H. K. Porter Company, Inc., Chicago, Ill., has been appointed assistant general manager of the division, as well as chief engineer. He was graduated from the Univeristy of Michigan and joined Delta-Star upon graduation. In 1941 he became research and development engineer and was promoted to chief engineer in 1944. He is a member of the National Electrical Manufacturers Association, American Society for Testing Materials, Western Society of Engineers, and Tau Beta Pi. He is serving on the AIEE Committee on Substations (1948–54).

R. N. Tomb (AM '39), sales engineer, apparatus department, General Electric Company, Washington, D. C., has been appointed manager of aircraft instrument sales, meter and instrument department. A native of Pennsylvania, Mr. Tomb attended the University of Pittsburgh, graduating in 1939 with a bachelor of science degree in electrical engineering. Joining General

Electric the same year on the test course at Philadelphia, Pa., he held a number of test and sales assignments in Schenectady, N. Y., and Washington, D. C., until entering the U. S. Navy in 1944. Following service in the Pacific theater, he returned to General Electric as a sales engineer in the company's apparatus sales office, Washington, where he was associated with the field of aeronautics. Mr. Tomb is a member of the American Society of Naval Engineers.

G. A. Rietz (M '50), manager, educational sales services, General Electric Company, Schenectady, N. Y., has been named manager of a newly established grants and services section in the educational relations services department. A 1926 graduate of South Dakota State College with a degree in electrical engineering, Mr. Rietz joined General Electric as a student engineer on the test course. In his early years with the company he conducted its first course in rural electrification and served as district rural electrification specialist in the Midwest. After serving as head of the rural electrification section of the central station department in Schenectady, Mr. Rietz was general assistant to the manager of the Central Station Customer Division. Following this he was appointed manager of the Farm Industry Division and later was manager of the educational service section. Mr. Rietz is past president of the American Society of Agricultural Engineers and a member of the American Society for Engineering Education.

C. T. Pearce (AM '36, F '49), Atlantic region engineering and service manager, Westinghouse Electric Corporation, Philadelphia, Pa., has been elected president of the Engineers' Club of Philadelphia for 1954–55. Mr. Pearce received his bachelor of science degree in electrical engineering from the University of New Mexico and his master of science degree from the University of Pittsburgh. He is a member of The American Society of Mechanical Engineers, the American Society of Naval Engineers, and the Pennsylvania Society of Professional Engineers. Mr. Pearce has served as chairman of the Philadelphia Section of the AIEE (1945–46) and on the Institute Committees on Membership (1946–49) and Rotating Machinery (1952–53).

Lloyd Espenschied (AM '18, F '30, Member for Life), research consultant, Bell Telephone Laboratories, Inc., New York, N. Y., retired recently. Mr. Espenschied is a co-inventor of the coaxial cable system and a pioneer in the development of wire and radio communications systems. He is also the inventor of the radio altimeter. Mr. Espenschied was born in St. Louis, Mo., in 1889, and is an industrial engineering graduate of Pratt Institute. Following his graduation in 1909 he was engaged as assistant engineer for the Telefunken Wireless Telegraph Company of America, and in 1910 he became development engineer for the American Telephone and Telegraph Company, New York, N. Y. He was transferred to the Bell Telephone Laboratories in 1934. A member of the Institute of Radio Engineers, he received that institute's Medal of Honor in 1940 "for his accomplishments as an engineer, as an inventor, as a pioneer in the development of radio telephony, and for his effective contributions to the progress of international radio co-ordination."

J. W. McNair (AM '25), head, electrical standards department, American Standards Association, New York, N. Y., has been appointed assistant technical director of the association. He will continue as secretary of the U. S. National Committee of the International Electrotechnical Commission.

Samuel Rosenbach (AM '23, F '48), assistant electrical engineer, Duquesne Light Company, Pittsburgh, Pa., has been appointed electrical engineer; and **E. H. Gue** (M '47), electrical station engineer, has been named electrical design engineer. Mr. Rosenbach began work with the company as a junior engineer in 1922. During his association with the company he has held jobs as senior engineer, district engineer, distribution engineer, general engineer, and assistant electrical engineer. Before joining Duquesne he was with the Santa Fe Railroad and the Western Electric Company. Mr. Rosenbach is a graduate of the University of New Mexico. Mr. Gue began work with Duquesne in August 1937 as a design engineer. Other positions he has held are senior design engineer, senior engineer, and electrical station engineer. He received bachelor and master of science degrees in electrical engineering from the University of Maryland. Mr. Gue is serving on the AIEE Committee on Transformers (1951–54)

W. C. Jenner (AM '46, M '53), experimental engineer, engineering department, Reliance Electric and Engineering Company, Cleveland, Ohio, has joined Houghton Laboratories, Inc., Olean, N. Y., as chief electrical engineer. Mr. Jenner graduated from Case Institute of Technology in 1933 with a bachelor of science degree in electrical engineering. From 1933 to 1943 he was with the Ohio Power Company, Lima, rising to the position of assistant superintendent of distribution. During World War II he served as a lieutenant commander in the U. S. Navy. He is a member of the American Society for Testing Materials, National Research Council, Conference on Electrical Insulation, Eta Kappa Nu, Tau Beta Pi, and Sigma Xi.

D. C. Luce (AM '36, F '49), president, Public Service Electric and Gas Company of New Jersey, Newark, has been elected a director of the Colonial Life Insurance Company of America. Mr. Luce, a graduate of Lehigh University, started with Public Service in 1924 as a cadet engineer in the electric department. He also has been vice-president in charge of electric operations and vice-president in charge of combined operations. He is a director of the Edison Electric Institute and a member of the American Gas Association.

H. V. Bozell (AM '08, F '23, Member for Life), formerly president, General Telephone Corporation, New York, N. Y., has been elected vice-president of the Roscoe B. Jackson Memorial Laboratory of Bar Harbor, Maine, and national chairman of the Jackson Laboratory Association. Mr. Bozell has been active in Jackson Laboratory affairs since November 1952 at which time he was appointed chairman of the Westchester chapter of the association. A native of Beloit, Kans., he was graduated from the University of Kansas with an electrical engineering degree in 1908, later obtaining his graduate degree in electrical engineering at the same institution. Until 1916 he taught and practiced electrical engineering and became the head of the department of electrical engineering of the University of Oklahoma, Norman. During this period he also served as chief signal officer of the Oklahoma National Guard. From 1916–21 he was assistant professor of electrical engineering at Yale University, New Haven, Conn., and became the editor of the *Electric Railroad Journal*, published by McGraw-Hill Company, in 1920. Later he became the editor of *Electrical World* and was the first editor of *Bus Transportation*. In 1925 Mr. Bozell joined Bonbright and Company, Inc. Later, in 1932, he became vice-president and a director of the Associated Telephone Utilities Company which became, in 1935, the General Telephone Corporation. In 1940 he became president, serving until his retirement in 1951. He is still identified with that corporation as a director and consultant. He has served on the following AIEE committees: Economics of Electric Service (1918–20); Superpower System (1920–21); and Standards (1923–25).

J. B. Owens (AM '45, M '53), supervisor, power switching equipment engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa., has joined the R and IE Division of the I-T-E Circuit Breaker Company, Greensburg, Pa., as assistant chief engineer. He will head engineering activities on power switching equipment. Mr. Owens is a graduate of Rice Institute with a bachelor of science degree in electrical engineering in 1941. After spending 1 year as a graduate student at Westinghouse Electric Corporation, he entered the switchgear department. In 1949 he was made supervisor of power switching equipment engineering.

A. C. Monteith (AM '25, F '45), vice-president in charge of engineering, Westinghouse Electric Corporation, Pittsburgh, Pa., has been named a director of the Atomic Industrial Forum, New York, N. Y.

H. P. Liversidge (AM '12, F '43, Member for Life), chairman of the board, Philadelphia (Pa.) Electric Company, has been elected chairman of the board of trustees of Drexel Institute of Technology, Philadelphia. An 1897 graduate of the institute, Mr. Liversidge was the first alumnus to be elected to the board in 1922. He is a recipient of the honorary degrees of doctor of science in commerce from Drexel in 1943 and doctor of engineering from Stevens Institute of Technology in 1940. Mr. Liversidge joined the staff of the Philadel-

phia Electric Company in 1898. He rose successively through operating positions to the posts of assistant electrical engineer, operating engineer, assistant chief engineer, vice-president (1924–26), vice-president and general manager (1926–38), director, president (1938–47), and chairman of the board since 1947. Mr. Liversidge is a member of the Electrical Association of Philadelphia, the Association of Edison Illuminating Companies, the Edison Electric Institute, the Thomas Alva Edison Foundation, Inc., The American Society of Mechanical Engineers, and the Illuminating Engineering Society. He has served on the following AIEE committees: Meetings and Papers (1920–21); Power Stations (1918–24, Chairman, 1920–21); Electrical Machinery (1923–24); Edison Medal (1927–29); and Code of Principles of Professional Conduct (1928–29).

G. W. Cooper (AM '42, M '47), apparatus engineer, Line Material Company, Cleveland, Ohio, has been promoted to manager, protective and switching equipment sales, with headquarters in Milwaukee, Wis. An electrical engineering graduate of Linsly Institute of Technology, Mr. Cooper joined Line Material in 1941 after several years of utility and industrial experience. He was employed initially in the company's transformer plant, Zanesville, Ohio, and in 1948 he was appointed apparatus engineer. While on a leave of absence from July 1951 to June 1952, Mr. Cooper served with the National Production Authority as chief, transformer section, Electrical Equipment Division.

R. C. Sprague (M '40, F '49), chairman of the board, Sprague Electric Company, North Adams, Mass., has been awarded the Medal of Honor of the Radio-Electronics-Television Manufacturers Association (RETMA). Mr. Sprague, third to receive the medal in the association's history, was honored for his contributions to the progress of the electronics industry. Mr. Sprague has been an RETMA director since 1943 and was chairman of its Parts Division from 1944 to 1946. He served as RETMA president in 1950 and became its first board chairman in 1951, a post which he still holds.

J. N. Jones (AM '45, M '52), Pacific Coast region electrical superintendent, Westinghouse Electric Corporation, San Francisco, Calif., has been appointed engineering and service manager for the Salt Lake City, Utah, office. He replaces **E. H. Hulse** (AM '41, M '47), who has been transferred to the East Pittsburgh, Pa., office, as mining, petroleum, and chemical section manager in the industry engineering department. Mr. Jones joined Westinghouse in 1936 at East Pittsburgh, serving in Los Angeles, Calif., until his transfer to San Francisco regional headquarters in 1949. A native of Mt. Vernon, Ohio, he was graduated from Carnegie Institute of Technology.

J. F. O'Donnell (AM '52), designer, electrical laboratory, International Business Machines Corporation, Endicott, N. Y., has been appointed associate engineer in the electrical laboratory. Mr. O'Donnell became associated with the company in 1951 when he was hired as a designer in development engineering. In May 1952 he was assigned to the electrical laboratory as a designer. A native of Great Neck, N. Y., he was graduated from the University of Michigan with bachelor of science degrees in mechanical and electrical engineering. He is serving on the AIEE Committee on Metallic Rectifiers (1953–54).

J. W. Forrester (AM '42, M '49), director, Digital Computer Laboratory, Massachusetts Institute of Technology (MIT), Cambridge, has been awarded the honorary degree of doctor of engineering by the University of Nebraska. The citation, naming Dr. Forrester as a distinguished alumnus of the university, continued "gifted engineer . . . ingenious inventor in the field of electronics as applied to national defense . . . skillful coordinator of pure science and engineering design." Dr. Forrester was graduated in electrical engineering from the University of Nebraska in 1939. He was a member of the MIT Radiation Laboratory during World War II and received the master of science degree from the institute in 1945. Since 1947, first in the Servomechanisms Laboratory and later as director of the Digital Computer Laboratory, Dr. Forrester has been in charge of designing, building, and operating Whirlwind I, the institute's large high-speed digital computer. In 1949 he was mentioned as one of the country's outstanding young electrical engineers by Eta Kappa Nu.

T. J. Higgins (AM '40, M '46), professor of electrical engineering, University of Wisconsin, Madison, has received the Westinghouse Award of $1,000 for outstanding teaching. Dr. Higgins was presented with the award, given annually to America's outstanding teacher in engineering, at the annual meeting of the American Society for Engineering Education. Professor Higgins joined the University of Wisconsin College of Engineering staff in 1948. He is a graduate of Cornell University and earned his doctor of philosophy degree at Purdue University. He is serving on the AIEE Committees on Basic Sciences (1947–54) and Feedback Control Systems (1952–54).

V. C. Rideout (AM '47), associate professor of electrical engineering, University of Wisconsin, Madison, has left for a year of teaching at the Indian Institute of Science, Bangalore, Mysore, India. Professor Rideout is the author of a new senior electronics textbook, "Active Networks." A member of the electrical engineering staff at Wisconsin since 1946, Professor Rideout will serve as a specialist in that field at the Indian Institute during the coming year.

R. S. Conrad (AM '51), supervisor, electrical and electronic system design groups, Chance Vought Aircraft, Inc., Dallas, Tex., has joined Sundstrand Aviation, Rockford, Ill., as chief application engineer. Mr. Conrad received his bachelor of science in electrical engineering degree from Iowa State College in 1939. He served as design engineer with Collins Radio Company for 9 years before joining Chance Vought as group supervisor, electrical-electronics installation group, in 1948. He became group supervisor of the two design groups in 1951. He is a senior member of the Institute of Radio Engineers.

H. R. Ciari (AM '50), division engineer, California Pacific Utilities Company, Susanville, has joined the service engineering staff of Shell Development Company's Emeryville, Calif., Research Center as an engineer. He is a graduate in electrical engineering from the University of Nevada.

S. E. Schultz (AM '25, F '47), chief engineer, Bonneville Power Administration, Portland, Oreg., has resigned. Mr. Schultz joined Bonneville as consulting engineer in 1939, shortly after construction was begun. He was presented the Milton H. Maguire award for an outstanding record in engineering skill and achievement by the Northwest Public Power Association in 1950. Mr. Schultz began his career as an electrical engineer with the Consumers Power Company in 1924, became assistant electrical engineer for Stevens and Wood, Inc., New York, N. Y., in 1925, and was appointed chief electrical engineer for the Port of New York Authority in 1935. He is a graduate of Drexel Institute of Technology and has served on the AIEE Committees on Transmission and Distribution (1944–46) and Transformers (1949–52).

C. E. Egeler (M '51), illuminating engineer, application engineering department, Lamp Division, General Electric Company, Nela Park, Cleveland, Ohio, retired June 1, 1954. Mr. Egeler started with the National Lamp Works of the General Electric Company in 1913, after his graduation from Purdue University. He saw active service in the U. S. Navy in World War I and in the summer of 1941 was again recalled to active Navy duty, advancing to the rank of captain. In 1946 he returned to the application engineering department, Nela Park, where he was in charge of industrial lighting, and marine and federal lighting activities for General Electric. He is a member of the Illuminating Engineering Society.

L. S. Billau (AM '08, F '50, Member for Life), electrical engineer, Baltimore and Ohio Railroad Company, Baltimore, Md., retired June 1, 1954. Mr. Billau was born in Cedar Rapids, Iowa, and was first employed in the test department of the General Electric Company, Schenectady, N. Y., after his graduation from the University of Minnesota with the degree of electrical engineer in 1905. Mr. Billau came to the Baltimore and Ohio in 1908 as an inspector in the electrical department, was promoted to assistant engineer in 1909, to chief draftsman in 1910, and to assistant electrical engineer in 1914. He has been electrical engineer since 1943. Mr. Billau is serving on the AIEE Committee on Land Transportation (1948–54).

R. S. Redmon (AM '23, M '31), chief engineer, Kellogg Company, Battle Creek, Mich., has been appointed vice-president in charge of engineering. Mr. Redmon

joined the Kellogg Company in 1938 as plant engineer for the Battle Creek plant. Prior to that Mr. Redmon was associated with Stone and Webster Engineering Corporation in both the construction and engineering divisions of that firm. He is an alumnus of the University of Cincinnati, having received his electrical engineering degree in 1921.

S. M. Rhodes (AM '53), has been appointed manager of the Electrical Division of the R. F. Ball Construction Company, Inc., and the Ball Southwest Corporation, San Antonio, Tex.

E. W. Engstrom (F '49), executive vice-president, RCA Laboratories, Radio Corporation of America, Princeton, N. J., has been elected executive vice-president, research and engineering, and continues as head of RCA Laboratories. His headquarters will be in New York, N. Y.

J. W. Mason, III (AM '37, M '51), sales engineer, Allen-Bradley Company, Detroit, Mich., has been appointed district manager of the Detroit office. Mr. Mason is a graduate in electrical engineering of the University of West Virginia in 1936. After 2 years with the General Electric Company in the industrial control engineering department, Mr. Mason became apparatus specialist for Raub Supply Company, Lancaster, Pa. He was called to active military service in December 1940 as first lieutenant in the Corps of Engineers. He left the service 5 years later as lieutenant colonel. From 1946 to 1951 he was supply sales manager for Raub. In 1951 he was again called to military duty to head the engineer design section for U. S. Army Construction in France. After his discharge in December 1952 he became affiliated with the Detroit office of Allen-Bradley as sales engineer.

George Hamburger, III (AM '44, M '48), manager, communication sales, Wire and Cable Division, Copperweld Steel Company, St. Louis, Mo., has moved his headquarters to Washington, D. C. Mr. Hamburger attended the University of Colorado and is a member of the American Institute of Mining and Metallurgical Engineers .

OBITUARIES • • • •

Karl Taylor Compton (F '31), chairman of the corporation of Massachusetts Institute of Technology (MIT), Cambridge, died June 22, 1954. Dr. Compton was born September 14, 1887, in Wooster, Ohio, and received the degrees of bachelor of philosophy, 1908, and master of science, 1909, from Wooster College and the degree of doctor of philosophy from Princeton University in 1912. He was a member of the Wooster College, Wooster, Ohio, and Reed College, Portland, Oreg., faculties before becoming assistant professor of physics at Princeton University, Princeton, N. J., in 1915. During World War I he served as an aeronautical engineer with the U. S. Army Signal Corps and later as scientific attaché at the American Embassy, Paris, France. At the conclusion of the war, Dr. Compton returned to Princeton as a full professor, later becoming head of the physics department. In 1930 he was elected to the presidency of MIT, a position which he held for 18 years. In 1948 he resigned as president of MIT to accept the chairmanship of the newly created National Military Establishment Research and Development Board, a position that he held until his resignation in 1949. He continued to serve as chairman of the corporation of MIT until his death.

Karl Taylor Compton

During World War II, Dr. Compton was one of the foremost scientists devoting their energies to the problems of the war. He was closely associated with the development of the atomic bomb and radar and guided missile techniques. He was a prolific writer on scientific subjects, having published more than 300 papers on thermionics, electric emission from hot filaments, and spectroscopy. He held 23 honorary degrees. Many awards for his research work had been received by Dr. Compton. In 1931 he was awarded the Rumford Medal by the American Academy of Arts and Sciences for contributions to the fields of spectroscopy and thermionic emission. In 1946 he received the U. S. Army Medal of Merit "for exceptionally meritorious conduct in the performance of outstanding services to his country." This is the highest military award that can be bestowed upon a civilian. In 1947 he received the Washington Award and the Marcellus Hartley Public Welfare Medal of the National Academy of Sciences. He became an honorary Commander of the Order of the British Empire and Commander of the Royal Norwegian Order of St. Olav in 1948. In 1949 he was awarded the Lamme Medal of the American Society for Engineering Education and in 1950 was the first recipient of the Proctor Award of the Society for Scientific Research. He was awarded the Hoover Medal for 1950 for "distinguished public service." He was president of the American Association for the Advancement of Science (1935–36), American Society for Engineering Education (1938–39), and American Physical Society (1927–29). He was a member of the American Optical Society, American Physical Society, Franklin Institute, and the American Academy of Arts and Sciences. Dr. Compton had served on the AIEE Edison Medal Committee (1940–45).

MEMBERSHIP • • •

Recommended for Transfer

The Board of Examiners at its meeting of June 9, 1954, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

To Grade of Member

Atkinson, W. R., supervising engr., General Electric Co., Pittsfield, Mass.
Behar, M. F., vice-pres. & editor, Instruments Publishing Co., Pittsburgh, Pa.
Converse, H. D., electrical engr., Maxon Construction Co., Inc., Oak Ridge, Tenn.
Davis, J. F., design engr., General Electric Co., Erie, Pa.
Edman, C. A., mgr., fan engg., General Electric Co., Bridgeport, Conn.
Ekroth, W. W., project engr., Bonneville Power Administration, Portland, Oreg.
Gisburne, E. H., application engr., I-T-E Circuit Breaker Co., Chicago, Ill.
Good, A. E., electrical engr., American Steel Foundries, Elmes & King Div., Cincinnati, Ohio
Gray, P. G., asst. prof. of elec. engg., Michigan State College, East Lansing, Mich.
Hallberg, L. K., estimator engr., Ebasco Services, Inc., New York, N. Y.
Heym, D. E., electrical engr., North Pacific Div., U. S. Corps of Engineers, Portland, Oreg.
Jankowski, H., engr., General Electric Co., Ithaca, N. Y.
Kepner, J. W., asst. supt. of system operation, Appalachian Electric Power Co., Roanoke, Va.
Kettenring, W. R., Jr., section engr., I&T Tube Div., General Electric Co., Schenectady, N. Y.
Levinson, N. M., field engr., Sprague Electric Co., North Adams, Mass.
Liu, L., designer, Niagara Mohawk Power Corp., Buffalo, N. Y.
Monius, G. F., senior engr., Consolidated Gas, Electric Light & Power Co., Baltimore, Md.
Percy, R. P., project engr., Westinghouse Electric Corp., Lima, Ohio
Percy, W. G., plant engr., Northwestern Bell Telephone Co., Minneapolis, Minn.
Rector, A. H., principal engr., Burns & McDonnell Engineering Co., Kansas City, Mo.
Rogers, E. J., asst. to chief, test & energization section, Bonneville Power Administration, Vancouver, Wash.
Rothwell, H. E., power apparatus specialist, General Electric Supply Co., Hartford, Conn.
Rudd, W. C., vice-pres. engr., New Rochelle Tool Corp., New Rochelle, N. Y.
Samson, D. R., application engr., General Electric Co., Schenectady, N. Y.
Shafranek, R. J., project engr., Jack & Heintz Inc., Bedford, Ohio
Swanson, J. O., chief, system operations sec., Bonneville Power Administration, Vancouver, Wash.
Tasse, Y. R., partner, Tasse, Sarault & Associates, C. E., Quebec, Que., Canada
Thaler, G. J., assoc. prof. of elec. engg., U.S. Naval Postgraduate School, Monterey, Calif.
Torchia, H. A., design engr., General Electric Co., Pittsfield, Mass.
Vidmar, J. F., supervising engr., The Ohio Bell Telephone Co., Cleveland, Ohio
Vitrogan, D., assoc. prof., Pratt Institute, Brooklyn, N. Y.
Volpe, R. W., design engr., General Electric Co., Erie, Pa.
Weston, E. R., prof. & acting director, school of elec. engg., Georgia Institute of Technology, Atlanta, Ga.
Zurheide, C. H., chief electrical engr., Fruin-Colnon Contracting Co., St. Louis, Mo.

34 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership, in the grade of Member, have been received from the following candidates, and any member objecting to election should supply a signed statement to the Secretary before August 25, 1954, or October 25, 1954, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Bowman, R. A., Bechtel Corp., San Francisco, Calif.
Harries, W. L., Massachusetts Institute of Technology, Cambridge, Mass.
Walker, A. P., National Association of Radio & TV Broadcasters, Washington, D. C.

3 to grade of Member

Report of the Board of Directors

THE BOARD OF DIRECTORS of the American Institute of Electrical Engineers presents to the membership its 70th annual report, covering the fiscal year ending April 30, 1954. As required by the Constitution, it contains a brief summary of the principal activities of the Institute during the year, a general balance sheet showing the financial condition of the Institute at the close of the fiscal year, a statement of cash receipts and disbursements, and a schedule of securities owned. Much additional information regarding the year's activities has appeared in *Electrical Engineering* throughout the year.

BOARD OF DIRECTORS' MEETINGS

Five meetings of the Board of Directors were held during the year, one in New York, N. Y., and one each in Atlantic City, N. J.; Vancouver, B. C., Canada; Kansas City, Mo.; and Chicago, Ill. At the meeting of April 7, 1954, which was held in Chicago, Secretary H. H. Henline was retired and N. S. Hibshman was elected Secretary.

Information regarding many of the more important matters which were considered by the Board of Directors appeared in various issues of *Electrical Engineering*.

ANNUAL MEETING

The 69th annual business meeting of the Institute was held in Atlantic City, N. J., June 15, 1953. A brief abstract of the annual report of the Board of Directors for the fiscal year ended April 30, 1953, was presented by Secretary H. H. Henline, who also gave a résumé of a report by Treasurer Walter J. Barrett on Institute finances.

Secretary Henline read the report of the Committee of Tellers on the results of the vote on proposed amendments to the Constitution. All proposed amendments were declared adopted.

The report of the Committee of Tellers on the vote of the membership on the election of officers whose terms were to begin on August 1, 1953, was presented by Secretary Henline. President Quarles presented a President's badge to Elgin B. Robertson who responded by thanking the members for their confidence in him, and giving a brief address on Institute progress.

President Quarles presented a certificate of honorary membership in the Institute to Major E. H. Armstrong. After thanking the members for the honor, Major Armstrong presented his address, "The Spirit of Discovery—A Tribute to the Work of Marconi."

The Lamme Medal for 1952 was presented to I. F. Kinnard, General Electric Company, West Lynn, Mass.

President Quarles gave an address on "Progress and Problems."

GENERAL MEETINGS

Four General meetings were held during the year, and a brief report on each follows:

Summer General Meeting. The 69th Summer General Meeting was held in Atlantic City, N. J., June 15–19, 1953, with a registration of 2,372, an all-time record for summer meetings.

There were 55 technical sessions at which 238 papers were presented, a management session with two papers, a session on electrical safety standards and practices with four papers, a session on electrical techniques in medicine and biology with four papers, the annual meeting, a session at which District prize-winning papers were presented, a Section delegates conference, meeting of the Board of Directors, meetings of many committees, numerous attractive inspection trips, several luncheons with speakers, President's reception and dinner, a dinner-dance, various entertainment events, and many events for the ladies. (*EE, Aug '53, pp 707–16*)

Pacific General Meeting. The Pacific General Meeting was held in Vancouver, B. C., Canada, September 1–4, 1953, with an attendance of more than 750.

The program consisted of a general opening session, 18 technical sessions with 64 papers presented, a student technical session, a meeting of Branch counselors and chairmen, a meeting of the Board of Directors, inspection and sightseeing trips, a golf tournament, the President's reception and dinner-dance, and a varied program for the ladies. (*EE, Oct '53, pp 930–2*)

Fall General Meeting. The seventh Fall General Meeting was held in Kansas City, Mo., November 2–6, 1953, with a registration of 950. In 26 sessions, 102 papers were presented. In addition, there was a general session, session on management, safety session, a meeting of the Board of Directors, and various committee meetings, many inspection trips, stag smoker, dinner-dance, and an elaborate schedule of events for the ladies. (*EE, Dec '53, pp 1115–19*)

Winter General Meeting. The Winter General Meeting was held in the Hotel Statler, New York, N. Y., January 18–22, 1954, with a record registration of 4,958. There were 95 sessions at which 410 papers were presented, a general session, a session on petroleum industry, management session, forum of technical committee chairmen, meeting of the Board of Directors, education committee meeting, various other committee meetings, luncheons, stag smoker, dinner-dance, many inspection trips, and events for the ladies. (*EE, Mar '54, pp 265–73*)

DISTRICT MEETING

Middle Eastern District Meeting (1953). A meeting was held in Charleston, W. Va., September 29–October 1, 1953, with a registration of 470. There were a general session, 17 technical sessions with 59 papers, a session on management, luncheon, banquet, inspection trips, and ladies' events. A meeting of the Middle Eastern District Executive Committee was held on September 28. (*EE, Nov '53, pp 1023–6*)

SPECIAL TECHNICAL CONFERENCES

Fourteen special technical conferences were held during the year ending April 30, 1954. Six were jointly sponsored in cooperation with other societies. AIEE sponsorship is by the technical committees in co-operation with the local Sections. In the aggregate 6,000 people attended these conferences and over 250 papers were presented. Brief summary reports follow.

National Telemetering Conference. The Joint AIEE–Institute of Aeronautical Sciences (IAS)–Institute of Radio Engineers (IRE)–Instrument Society of America (ISA) National Telemetering Conference was held in Chicago, Ill., May 20–22, 1953, and was attended by 305 persons. Six sessions were held during the 3 days, and 33 papers were presented. In addition there was a luncheon and a banquet with addresses. The papers were published as the "1953 National Conference Record." (*EE, Jul '53, p 645*)

AIEE Aircraft Technical Conference. This conference was held in Seattle, Wash., September 29–October 3, 1953, with an attendance of 382 engineers from all parts of the United States. Thirty-four papers were presented at the eight sessions, ten of them with *Transactions* status. Inspection trips, a banquet, and exhibits were also scheduled. Conference proceedings were published. (*EE, Dec '53, pp 1119–20*)

AIEE Conference on the Application of Motors to Air-Moving Equipment and Symposium on Induction Motors. This conference, sponsored by the Committee on Rotating Machinery and the Fort Wayne Section of AIEE, was held in Fort Wayne, Ind., October 6–8, 1953, with an attendance of 355. This is the second conference on small motors and their application to a special line of products. Twenty-two papers were presented in eight sessions and two luncheons held. Proceedings were not published. (*EE, Dec '53, p 1123*)

Machine Tool Conference. This was the sixth annual AIEE conference sponsored by the AIEE Subcommittee on Machine Tools, and it was held in Cleveland, Ohio, October 14–16, 1953, with an attendance of 584. Nine papers were presented and the AIEE Cleveland Section acted as host and took care of all local arrangements including plant tours, banquet, and so on. Conference proceedings were not published. (*EE, Dec '53, p 1126*)

Fall Textile Conference. This Conference on Electric Equipment for the Textile Industry was held at North Carolina State College, Raleigh, October 29–30, 1953, with an attendance of 250. The meeting was sponsored by the Textile Subcommittee of the AIEE General Industry Applications Committee, the North Carolina Section of the Institute, and the Department of Electrical Engineering and School of Textiles of North Carolina State College. There were three sessions at which eight technical papers were presented covering power, control, and protection of equipment as well as a paper covering "A Progress Report on Development and Standardization of Textile Mill

Control Enclosures," a panel discussion on "Electrical Problems and Remedies," a luncheon, social hour, and barbecue dinner. Conference proceedings were not published.

Conference on Electronic Instrumentation and Nucleonics in Medicine. The sixth annual conference on this subject was held on November 19–20, 1953, New York, N. Y. Jointly sponsored by the AIEE through its Committee on Electrical Techniques in Medicine and Biology, the IRE through its Professional Group on Medical Electronics, and the ISA, 17 papers were presented in four sessions with an evening demonstration lecture. The total attendance was 216 which roughly divided into 74 working in biological or medical field and 142 in engineering or sales. Conference proceedings were not published. (*EE, Jan '54, pp 83–4*)

Eastern Computer Conference. This joint conference which was held in Washington, D. C., December 8–10, 1953, had as its theme, "Information Processing Systems—Reliability and Requirements." More than 1,000 engineers attended the six technical sessions in which 24 papers were presented and visited the elaborate exhibits of nearly 40 manufacturers displayed in three rooms adjacent to the ballroom. Seven inspection trips to near-by Government bureaus and laboratories were made where computers are functioning. In addition to AIEE, the sponsors were the IRE and the Association for Computing Machinery (ACM). Conference proceedings were published by the IRE. (*EE, Feb '54, p 169*)

Scintillation Counter Symposium. The fourth Scintillation Counter Symposium was held in Washington, D. C., January 26–27, 1954. Twenty-six papers were presented in four sessions in addition to an evening round-table discussion. The attendance was approximately 400. In addition to the AIEE, the sponsors were the IRE, Atomic Energy Commission (AEC), and the National Bureau of Standards (NBS). Papers were published by *Nucleonics*. (*EE, Mar '54, p 275*)

Western Computer Conference and Exhibit. This conference, held February 11–12, 1954, in Los Angeles, Calif., had as its theme "Trends in Computers: Automatic Control and Data Processing." It was jointly sponsored by the AIEE, IRE, and ACM. The program was comprised of 26 papers, opening ceremonies, two sessions on automatic control, two sessions on data processing, and five discussion groups. Exhibits featured general-purpose digital computers, analogue computers, analogue-digital conversion equipment, data-handling equipment, and specialized computer components. Approximately 1,100 attended. Conference proceedings were published.

Conference on Transistor Circuits. This conference was held in Philadelphia, Pa., on February 18–19, 1954, under the joint sponsorship of the IRE Professional Group on Circuit Theory and the Science and Electronics Division of AIEE. The University of Pennsylvania and the AIEE Philadelphia Section were hosts and the attendance was over 600. The program included 18 papers presented in four sessions on the circuit properties of junction and surface-barrier transistors, and their use in linear and nonlinear applications. A cocktail buffet supper was held. Emphasis was on material not previously available in the literature, and the program was designed to be of greatest value to engineers who already possessed some knowledge of transistor circuit behavior. Conference proceedings were not published. (*EE, Apr '54, pp 369–70*)

Sixth Annual Rubber and Plastics Conference. This conference was held on April 5–6, 1954, in Akron, Ohio, with the Akron Section acting as host. The program consisted of eight papers, a banquet, and inspection trips, and the attendance was 211. Conference proceedings will be published. (*EE, Jun '54, p 565*)

Southern Textile Conference. This conference was held at the A. French Textile School, Georgia Institute of Technology, Atlanta, Ga., April 15–16, 1954, with a registered attendance of 125. The program was comprised of eight papers presented in three sessions and a luncheon. A report was presented on the development of standards for the enclosures of mill control equipment. Conference proceedings were not published. (*EE, Jun '54, pp 564–5*)

Conference on Feedback Control Systems. This second conference on this subject sponsored by the AIEE was held in Atlantic City, N. J., April 21–23, 1954, with approximately 300 in attendance. Addresses and 13 papers were presented in three sessions, some 14 demonstrations were scheduled in two periods, and there was a social hour and dinner. The demonstrations of actual equipment and components scheduled at different times with opportunities for questions and discussion provided a novel means of presentation which met with enthusiasm. Conference proceedings will be published. (*EE, Jul '54, pp 668–9*)

General Committees

BOARD OF EXAMINERS

The Board of Examiners met every month, except August, and acted on 4,586 applications for admission or proposals for transfer. This figure is just above the number of cases processed last year (4,575) and seems to reflect a leveling-off of the downward trend evident last year as a result of the changes in the Constitution which had been put into effect the previous year. With the increasing demand for engineers and the consequent interest in professional society activities, the figures for subsequent years should show an increase.

A continuing problem is the inadequate descriptions of professional accomplishments of many applicants which, aside from the additional time and expense involved in obtaining the necessary information, is not to the applicant's advantage. The Examiners must and do make their decisions on the basis of the descriptions of the applicant's work—merely dates and titles alone are never sufficient.

In the proposal of a candidate for Fellow grade it is particularly necessary to give not only a complete description of the engineering work performed, but a clear statement setting forth the parts of the career that have been of distinction. The "distinction" is essential to the present requirements for Fellow grade and may be achieved through any one or a combination of the qualities of importance, responsibility, and originality. The "Guide" just issued by the national Transfers Committee gives several examples of types of work which might and those which might not qualify a candidate for Fellow grade. Copies of the "Guide" may be obtained from Headquarters upon request.

The membership requirements of 26 technical societies have been studied to determine their comparability with requirements for AIEE Member grade in connection with applications for direct admission to Member grade on the basis of paragraph *5d* of the Constitution.

Study of methods whereby curricula of colleges which have not yet received the approval of Engineers' Council for Professional Development (ECPD) might be accepted under *S6* of part (*1*), is continuing in the Committee on Student Branches and in the Board of Examiners.

Table I. Applications and Proposals Received by the Board of Examiners, 1953–1954

Admission		
Affiliate		
Recommended	306	
Not recommended	0	306
Associate Member		
Recommended	3,258	
Re-elected	165	
Not recommended	140	3,563
Member		
Recommended	63	
Re-elected	9	
Not recommended	4	76
Total admission cases		3,945
Transfer		
Associate		
Recommended	4	
Not recommended	0	4
Member		
Recommended	554	
Not recommended	36	590
Fellow		
Recommended	46	
Not recommended	1	47
Total transfer cases		641
Total cases		4,586
Student member enrollment		3,607
Grand total		8,193

Table IA. Some Important Trends in Table I

	1953	1954	Per Cent Increase
Transfers to Member	494	590	19.5
Transfers to Fellow	26	46	77
New students enrolled	2,656	3,607	36

COMMITTEE ON THE CODE OF PRINCIPLES OF PROFESSIONAL CONDUCT

During the Institute year, the Committee on the Code of Principles of Professional Conduct has held one meeting. At that meeting, two complaints of the violation of the Code of Professional Conduct were discussed and disposed of.

At the meeting the following resolution was unanimously passed:

"That this committee recommends to the Board of Directors that the American

Institute of Electrical Engineers lend its support to placing the General Electrical Engineers Association plan for unity, as published in *Electrical Engineering*, into effect."

This resolution in accordance with the action of the committee was submitted to the Board of Directors of the Institute. The directors referred the resolution to the AIEE representative of the Engineers Joint Council (EJC). The Board of Directors did not make a definite request that the matter be taken up, and no action was taken.

This year has been unique in that no instances of any violations of the code have been called to the committee's attention.

COMMITTEE ON CONSTITUTION AND BYLAWS

No proposals to amend the Constitution have come before the committee this year. Four amendments to the Bylaws were prepared and have been approved by the Board of Directors.

The changes made in the Constitution last year which provided for technical representatives on the Nominating Committee required changes in Section *23* of the Bylaws.

At the Atlantic City, N. J., meeting in June 1953, a special committee of the Board of Directors presented a report recommending that an Advisory Committee in Honors be set up. The Bylaws have been amended to permit this procedure by adding a paragraph at the end of Section *2* and a new paragraph numbered tentatively as Section *67b*. At a later meeting of the Board of Directors this amendment was further amended to provide a wider range of selection of committee members.

At the Kansas City meeting in November 1953, the Board of Directors approved an agreement with the ASME, under the terms of which members of one of these societies could become members of the other society without the payment of the usual entrance fee. Section *12* of the Bylaws was amended to cover this arrangement by adding two paragraphs.

COMMITTEE ON EDUCATION

The Committee on Education held two meetings during the year, one at Kansas City, Mo., and one in New York, N. Y. At the Winter General Meeting, they co-sponsored, with the Subcommittee on Electronic Education of the Electronics Committee, a conference session on problems in electronic education which was well attended and led to considerable discussion.

In co-operation with the Safety Committee, a study of safety in college laboratories is being undertaken. With the construction of many new laboratories since the war with dead-front practices, the question is not so much that of actual safe practices in the college laboratory, as it is training in safe practices which will carry over to industrial practice where equipment may not always be so well safeguarded.

A subcommittee of the Education Committee is undertaking the study of the teaching of general physics in electrical curricula. Because of the heavy emphasis of most physics departments on the nuclear area, it is felt that the general classical areas are being neglected, and considerable question exists as to the quality of teaching now being received by electrical engineering students at the freshman and sophomore level. It is hoped that this committee may have a report at the next Winter General Meeting.

Due to the close timing and wide geographic separation between the Summer General Meeting and the meeting of the American Society of Engineering Education (ASEE) this year as well as in the past, an experiment will be undertaken in 1954 of holding the summer meeting of the committee in connection with the ASEE convention rather than with the Summer General Meeting. Realizing that very little can be done towards avoiding some of these meeting conflicts, it is hoped that this experiment may aid in furthering the activities of the committee.

FINANCE COMMITTEE

The finances of the Institute continue in a satisfactory condition despite the fact that expenditures exceeded the total operating income for the fiscal year ending April 30, 1954, by approximately $6,100. A complete statement of income and expenses for the year is included in the annual report of Haskins and Sells, Certified Public Accountants, which appears in the closing pages of this report.

The constant expansion in membership services, particularly in the field of publications, accounts chiefly for the excess of expenditures; over $622,000 was devoted to publications during the past fiscal year, an increase of over 14 per cent in the amount expended for the same purpose last year. In all other activities the Institute is endeavoring to meet the requirements of an increasing membership, as evidenced by the fact that the budget for the appropriation year beginning October 1, 1953, contemplates a total outlay of over $1,260,000, and a substantial budget deficit. This situation reflects the necessity for a reappraisal of the financial operations to arrive at a realistic balance of services and income.

COMMITTEE ON MANAGEMENT

The Committee on Management has sponsored a session at each of the General meetings. At these sessions, outstanding authorities in the field of management have been invited to present papers on various phases of general management. Very substantial interest has been shown and the discussions have been at a high level. Speakers have been requested to bring 200 copies of the papers to each of the meetings. This has proved insufficient and the authors have received as many as 200 requests for additional copies. Because of the interest shown in these papers, a number have been selected for publication as general interest articles in *Electrical Engineering*.

The committee met during the Winter General Meeting and reviewed its objectives. Agreement was reached on the following:

1. The present type of session should be continued.
2. The chairman should look into obtaining closer contact with other organizations functioning in this field.
3. The committee strongly endorsed publication of papers on management in *Electrical Engineering*.
4. The committee will encourage and sponsor the formation of organizations to present management programs at the Section level.

This last-named activity is now in progress and represents the committee's major undertaking for the year. A substantial number of Sections have already initiated management committees or management programs. The committee knows of a number of other Sections which are considering such activity for next year and intends to give this the maximum encouragement.

COMMITTEE ON MEMBERS-FOR-LIFE FUND

The committee again gave consideration to the best application of the income of this fund, and recommends to the Board that the practice be continued of defraying in part the expenses of the winners of District prizes in attending the Summer General Meeting of the Institute.

The committee took notice of the fact, however, that the present use of the fund does not deplete the income by a large percentage. For instance, in 1952–53 the dues paid amounted to $2,875 and traveling expenses of the District prize winners amounted to $1,513. The balance of the fund is $16,300. In view of this, the committee feels that consideration should be given to some additional project to which some of the money might be applied. Several suggestions have been made. For example, these include building up a capital fund which might be put to a useful purpose if and when the Institute moves to new quarters; establishment of a medal or medals for outstanding work in specific branches of electrical engineering; financial award to an outstanding young engineer.

The committee is not at this time making any definite recommendation as it has not had time to give serious consideration to the many possibilities, and it is merely passing the suggestions on to the incoming committee for further study.

MEMBERSHIP COMMITTEE

Membership in the Institute reached a new high of 47,923 at the close of the fiscal year. The increase of 2,497 during the year represented the fifth largest numerical gain on record. This is a gain of 5.5 per cent, a decrease from last year's figure of 7.6 per cent.

Table II shows the distribution of the membership among the various grades. The grade of Affiliate grew from 331 to 667 members during the year.

During the year 3,704 applications were received, of which 1,157 were from students and 2,547 from others. Student applications last year were 1,614, 2,591 2 years ago, and 4,168 3 years ago. The decline from these figures is due largely to the decline in Student membership in previous years. This decline appears to be checked. The applications from other than students is the highest on record.

Student membership increased to 6,904 from 6,782 for last year. This marks the end of the decline in Student membership experienced since 1950 when an all-time high of 20,668 was reached. In co-operation with the Committee on Student Branches and the Sections Committee efforts are continuing in encouraging undergraduate students to become Student members and graduate Student members to apply for Associate Member grade.

Members in arrears for dues numbered 1,969, or 4.1 per cent; this is about the same as last year when 1,937 or 4.3 per cent were delinquent.

The committee is especially appreciative of the co-operation of the Student Branch

Table II. Membership Statistics for Fiscal Year Ending April 30, 1954

	Honorary Members	Fellows	Members	6-Year Associate Members	Associate Members	Affiliates	Subtotals	Totals
Membership April 30, 1953	5	1,491	10,677	11,597	21,325	331		45,426
Additions:								
New members qualified			59		3,619	350	4,028	
Former members reinstated or re-elected			30	115	171		316	
Subtotals			89	115	3,790	350	4,344	
Transfers	1	53	482	2,350	2		2,888	
Totals	1	53	571	2,465	3,792	350	7,232	
Deductions:								
Died	2	30	106	75	30		243	
Resigned		6	59	169	229	3	466	
Dropped		1	82	317	729	9	1,138	
Subtotals	2	37	247	561	988	12	1,847	
Transfers			54	428	2,404	2	2,888	
Totals	2	37	301	989	3,392	14	4,735	
Net Changes	−1	16	270	1,476	400	336	2,497	
Membership April 30, 1954	4	1,507	10,947	13,073	21,725	667		47,923

Table III. Number of Applications Received From Student Members and From All Others

Year Ending April 30	Students	All Others	Total
1954	1,157	2,547	3,704
1953	1,614	2,405	4,019
1952	2,591	2,430	5,021
1951	4,168	2,082	6,250
1950	4,033	2,417	6,450
1949	2,286	2,192	4,478
1948	1,481	2,272	3,753
1947	938	2,331	3,269
1946	308	2,453	2,761
1945	249	2,179	2,428
1944	466	1,908	2,374
1943	783	1,431	2,214

Table IV. Number of Student Members as of April 30

Year	New Applications	Renewals	Total
1954	3,571	3,333	6,904
1953	2,744	4,038	6,782
1952	3,023	5,834	8,857
1951	4,635	10,393	15,028
1950	7,876	12,792	20,668
1949	9,967	9,461	19,428
1948	7,876	6,041	13,917
1947	5,092	3,929	9,021
1946	2,574	2,513	5,087
1945	2,326	2,287	4,613
1944	2,242	2,656	4,898
1943	2,512	3,200	5,712

Table V. Record of AIEE Membership

Year	Total May 1	Year	Total May 1	Year	Total May 1
1884	71	1908	5,674	1931	18,334
1885	209	1909	6,400	1932	18,003
1886	250	1910	6,681	1933	17,010
1887	314	1911	7,117	1934	15,230
1889	333	1912	7,459	1935	14,269
1890	427	1913	7,654	1936	14,600
1891	541	1914	7,876	1937	15,308
1892	615	1915	8,054	1938	16,078
1893	673	1916	8,202	1939	16,605
1894	800	1917	8,710	1940	17,213
1895	944	1918	9,282	1941	17,886
1896	1,035	1919	10,352	1942	18,944
1897	1,073	1920	11,345	1943	20,161
1898	1,098	1921	13,215	1944	21,407
1899	1,133	1922	14,263	1945	23,072
1900	1,183	1923	15,298	1946	25,090
1901	1,260	1924	16,455	1947	26,470
1902	1,549	1925	17,319	1948	28,408
1903	2,229	1926	18,158	1949	30,791
1904	3,027	1927	18,344	1950	34,198
1905	3,460	1928	18,265	1951	38,058
1906	3,870	1929	18,133	1952	42,220
1907	4,521	1930	18,003	1953	45,426
				1954	47,923

counselors and of the Section chairmen in their efforts in checking the decline in applications from Student members.

COMMITTEE ON PLANNING AND CO-ORDINATION

The principal matters considered by the committee may be summarized as follows:

Meetings. Recommendations were made to, and approved by, the Board of Directors regarding locations and dates of future General and District meetings as indicated in the schedule.

Future District meetings will be held in the spring as a result of a policy recommended to the Board by the Committee on Planning and Co-ordination.

The Fall General Meeting will be held in Chicago, Ill., for the next 3 years with the 1955 and 1956 dates co-ordinated with those of the National Electronics Conference.

A joint committee representing Planning and Co-ordination, Technical Operations, Publication, and Finance was organized to study and recommend methods for including the financing of special technical conferences as a part of the regularly budgeted operations of the Institute.

ASME-AIEE Membership Agreement. After study and recommendation by the Committee on Planning and Co-ordination, the Board of Directors acted jointly with the board of ASME to provide for the waiving of entrance fees for any member of either society seeking admission to the other.

Redistricting. After long study and exhaustive exploration of possible changes in the geographical Districts for the purpose of reducing the travel demands on District officers, the Subcommittee on Redistricting asked to be discharged and to have the problem referred to a committee of the Vice-Presidents of Districts 1, 2, 4, 5, and 7.

Questionnaire. At the request of EJC and on reference from the board, the committee undertook to design and test a questionnaire for the purpose of exploring the situation and opinions of the AIEE membership in matters having to do with "Employment Conditions" in the engineering profession. A trial questionnaire was sent to a 1-per-cent sample of the membership (the Lehigh Valley Section members). The returns are under study and the final edition is being prepared as the fiscal year comes to a close.

Schedule of Approved Meetings

1954

North Eastern District (1), Van Curler Hotel, Schenectady, N. Y., May 5–7

Combined Summer and Pacific General, Hotel Biltmore, Los Angeles, Calif., June 21–25

Middle Eastern District (2), Abraham Lincoln Hotel, Reading, Pa., October 5–7

Fall General, Hotel Morrison, Chicago, Ill., October 11–15

1955

Winter General, Hotel Statler, New York, N. Y., January 31–February 4

Southern District (4), St. Petersburg, Fla., April 13–15

Middle Eastern District (2), Columbus, Ohio, May 4–6

Summer General, New Ocean House, Swampscott, Mass., June 27–July 1

Fall General, Hotel Morrison, Chicago, Ill., October 3–7

1956

Winter General, Hotel Statler, New York, N. Y., January 30–February 3 (tentative)

North Eastern District (1), Rochester, N. Y., May 2–4

Combined Summer and Pacific General, San Francisco, Calif., June 25–29

Fall General, Hotel Morrison, Chicago, Ill., October 1–5

1957

North Eastern District (1), Pittsfield, Mass., spring (tentative)

Summer General, Montreal, Que., Canada, June 24–28 (tentative)

1958

Summer General, Buffalo, N. Y., June (tentative)

COMMITTEE ON AWARD OF INSTITUTE PRIZES

One of the principal functions of this committee is the administration of Institute prize awards for papers delivered during the previous administrative year. The recommendations of the several divisions for Institute prize awards were reviewed and approved, and first and second prize selections were made from a total of 16 student papers. All of these awards were presented on January 18, 1954. The committee kept

in touch with activities on District, Section, and Branch prize awards.

A comparison was made of AIEE prize paper arrangements with those of other national technical societies. While this showed some differences, it was concluded that the present AIEE pattern is sound.

Somewhat more than 2 years ago, because of the feeling in various quarters that the rules governing awards for AIEE papers needed improvement, consideration of possible revisions was initiated. As was to be expected, divergent views led in the beginning to some confusion and thoughtful consideration has been required to crystallize ideas. After discussing varying degrees of departure from present procedures, the Committee on Prize Awards agreed upon a draft of new rules in which the satisfactoriness of present procedures reflected itself in relatively small changes. The principal modifications proposed are as follows:

1. In view of the feeling that to be of prize caliber a division paper must necessarily be of *Transactions* quality, this has been made a requirement.
2. In addition to the division first and second prizes, provision has been made for additional certificates when needed to recognize especially meritorious papers.
3. A prize is made available for the occasional recognition of an outstanding paper outside division scope, on such subjects, for example, as research, safety, education, etc.
4. Procedures for handling of awards at Headquarters have been clarified and the present deadline dates, which have frequently proved embarrassing, have been modified.
5. Only minor changes have been made in the procedures for Student, District, Section, and Branch awards.

The draft of the new procedures has been approved by the divisions and the Committee on Technical Operations and has been commented upon by the Vice-Presidents, Sections Committee, and the Committee on Student Branches. It is hoped that the new procedures will be placed in effect for the new administrative year.

PUBLICATION COMMITTEE

Analysis of trends in each of the four categories of Institute publications—*Electrical Engineering*, bimonthly publications, *Transactions*, and special publications—indicates healthy possibilities of continued growth and development in each. The largest number of papers and the most pages in the history of the Institute were published in the current year ending on April 30, 1954.

Electrical Engineering. Articles for *Electrical Engineering* have been selected on the basis of breadth of interest for the greatest number of members. The division of technical content has been brought more closely in line with the primary interests of members in five broad fields as expressed in the 1951 questionnaire and shown in Table VI.

Principal changes during the year consisted of an increase in the "Current Interest" section by 30 pages and an increase in the "Institute Activities" section of 41 pages. The latter increase has been due to greater Institute activity and the inclusion of a section on members elected to the Fellow grade. Forty more 1-page digests were published during the current year than in the previous year. To compensate for these increases, 18 less articles and papers were published. The distribution of 1,238 editorial pages in the 12 issues is shown in Fig. 1.

Advertising. The total number of paid advertising pages in *Electrical Engineering* for the year ending April 1954 was 970 pages, the same number as for the previous year. The total number of pages for the first 4 months of 1954 was 315 pages, which is nine less pages than the number during the same period of the previous year. The advertising director attributes the slight reduction in number of pages to the change in economic conditions brought about by less defense production and as many pages of advertising are expected by the end of 1954 as were had during the previous year. Comparison with other technical publications indicates that *Electrical Engineering* experience is much the same as that of others in its field.

Bimonthly Publications. These publications have become increasingly popular and during the year there have been substantial increases in the number of both free subscriptions and paid subscriptions to all three of these publications: *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*. The number of subscriptions to each of these publications as of May 1953 and the increases during the year are shown in Fig. 2.

AIEE Transactions. Volume 72 of the 1953 *Transactions* was made available in March and April in three parts corresponding to the bimonthly publications. The

Fig. 1. Distribution of 1,238 editorial pages in 12 issues of Electrical Engineering

total number of papers in all three parts was 388 and the total number of pages 2,720. This is a 36.6-per-cent increase in the number of papers and a 31-per-cent increase in the number of pages over volume 71 of the 1952 *Transactions* and it represents by far the greatest amount of technical material ever published by the Institute in one annual volume.

Contrary to some belief, the bimonthly publications have not decreased the demand for the annual bound volumes of *Transactions* as the four previous volumes are now out of stock. Parts I and II of the 1954 *Transactions* will be increased by 500 to a

Table VI. Comparison of Subject Matter in Electrical Engineering With Primary Interest of Members

	Primary Interests of Members (1951 Questionnaire)		Technical Articles in Electrical Engineering (Per Cent)	
			Year Ending in April	
	Number	Per Cent	1953	1954
Science and electronics	3,268	16.9	38.4	26.9
Communication	2,562	13.2	10.3	19.3
Power	8,537	44.0	20.5	26.9
Industry	3,231	16.7	12.0	14.8
General applications	1,405	7.2	18.8	12.1
None	393	2.0		
Totals	19,396	100.0	100.0	100.0

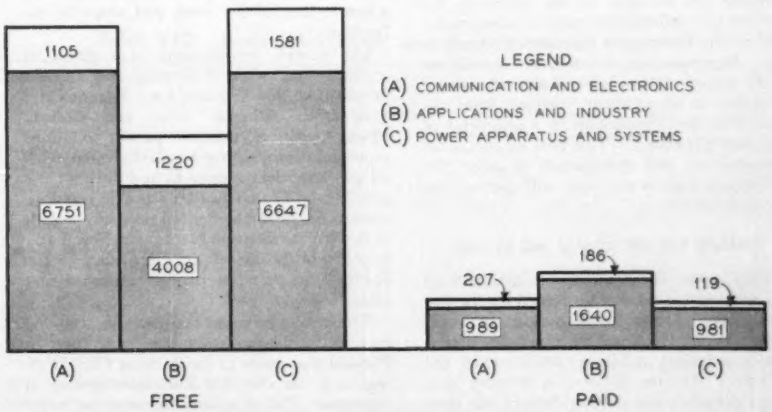


Fig. 2. Increase in subscriptions to bimonthly publications: May 1953–April 30, 1954

Table VII. Special Publications Made Available in the Year Ending April 30, 1954

		No. of Papers	No. of Pages
S-56	Symposium on the Use of Aluminum for Insulated Conductors (7/53)	10	64*
S-57	Aircraft Technical Conference (10/53)	34	468
S-57D	Part II. Discussions (4/54)		48
S-58	Electrical Engineering Problems in the Rubber and Plastics Industries (10/53)	9	142
	Totals	53	722

* Printed

4,500 edition and Part III will be increased by 750 copies to a 4,750 edition.

AIEE Special Publications. Four special publications containing a total of 53 papers and 722 pages were completed during the year, which is three less than the number issued during the previous year. The decrease is momentary as recently several new special publications have been authorized which will be made available in the next few months.

Committee Activities. A joint subcommittee, headed by C. S. Purnell, chairman of the Finance Committee, made a thorough study of the increases in printing prices over a period of years in comparison with the increases experienced by similar societies and commercial publishers as well as a canvass of the prices of other printing firms with facilities to do the work. The subcommittee concluded that in terms of present-day costs the Institute was paying a fair market price for its printing work.

Conference Papers. After long study and many surveys of the demand for conference papers, the committee has concluded that any paper presented at technical sessions or conferences must in some way be made available to the Institute's membership. The committee has concluded that such papers as are received in reproducible form 60 days in advance should be reproduced, distributed, and sold by the Institute in the regular manner. The committee also recommends that papers which cannot be completed in time to be reproduced by the Institute be brought to the meetings by authors in a sufficient number of copies to be sold by the Institute at the time of the meeting. Depending on the ultimate disposition of the paper, a copy of it should always be available in some form, ranging from inclusion in the *Transactions* to a photostat of the copy presented. This new emphasis on reproduction and distribution of some 300 conference papers per year will cost on the order of $20,000.

COMMITTEE ON PUBLIC RELATIONS

This report summarizes the activities of the Committee on Public Relations for the fiscal year. During that period the committee consolidated and extended the current public relations–publicity activities of the Institute. It also initiated a broader program designed not only to benefit the electrical engineering profession and the Institute, but one that would furnish the public with a better understanding of the aims, objectives, and achievements of the profession. This was done by the inauguration of additional services to press, magazines, news syndicates, radio, television, and other media.

The present work of assistance to the Sections, Subsections, technical conferences, and General and District meeting committees was increased by having personal on-the-spot service provided at the major meetings by representatives of the public relations counsel and his staff. The Sections, Subsections, and other units of the Institute were furnished with a new Publicity Kit containing ready-to-use publicity materials at the local level. The kit also contained a manual showing publicity chairmen how these tools could be used. Six issues of the *Publicity News Letter*, illustrated, were prepared and distributed to Section publicity chairmen and others. This house organ contained information on what various publicity committees were doing in their communities, and suggestions that might be useful in making their programs more effective. A keen interest has been manifest in the *News Letter* on the part of publicity chairmen who are sending information concerning their activities, of which they are proud and which they think might help others. The committee reports a rising interest in public relations and publicity both in the United States and Canada by AIEE leadership. This was evidenced by the increasing number of Sections which are now publishing their own news letters for Section members. New York, Philadelphia, and Pittsburgh Sections are now publishing such news letters regularly. The committee's public relations counsel has been able to co-operate with the editors of some of these Section news letters. These news letters are designed to keep the Section membership up to date on activities in their Sections. Perhaps one of the striking evidences of the mounting interest in AIEE public relations and publicity is the fact that more than 80 Sections now have publicity committees, many of them very active and alert.

The committee through the public relations staff of its counsel assisted in the preparation and illustration of several promotional brochures for the Institute and Sections, one of which was aimed at increasing Student membership. Aid was provided in the preparation of an illustrated slide lecture for the Sections to give members a better idea of the work and scope of the Institute.

On-the-spot co-operation was given to publicity chairmen of General and District meetings at New Orleans, La., Kansas City, Vancouver, Atlantic City, and Boston, Mass., with a trained public relations representative helping local chairmen with all publicity details prior to and during their meetings. The committee's public relations counsel as usual handled all publicity details of the Winter General Meeting in New York, which was the largest in the history of the Institute in point of papers presented and attendance.

The public relations counsel also attended several Publicity Committee meetings in Philadelphia prior to the Atlantic City meeting, and has attended a similar meeting in Allentown, Pa., in connection with the forthcoming Middle Eastern District Meeting next October. Constant contact is kept with the publicity chairmen of all General and District meetings in order to furnish them all possible aid.

In connection with the broadened scope of the program to reach the public outside the engineering profession, various activities are now being carried on. They include the preparation of a series of radio scripts for use in the Sections and will be made available to publicity chairmen as soon as they are ready. Another phase of this part of the program is a series of illustrated mats for newspapers and magazines, depicting various activities and achievements of the electrical engineering profession. These have been supplied to several thousand newspapers and have been made available to Section Publicity chairmen for local use. The public relations counsel also is contacting general and class magazines to interest editors and writers in publishing interpretative articles concerning progress of electrical engineering.

Institute news and special features have been publicized extensively. Information on awards such as the Edison and Lamme Medals have been made available to the press, trade press, and radio. Articles on new Fellows of the Institute and other honors conferred on members have been sent to home town papers of recipients, as well as to the daily press on a national scale.

Considerable aid has been given to the New York Section, due to its proximity. The Section's monthly meetings have been publicized and upon presentation of past chairmen pins, to those who had served for the last 30 years, photos were taken and made available to *Electrical Engineering*, *Electrical World*, and other national electrical magazines. One of these photos was used in the initial issue of the New York Section *News Letter*.

The advance of the public relations program has been made possible by the support and co-operation of officers and committees of AIEE Headquarters. The chairman found it very helpful to attend various meetings in New York and other cities in conjunction with the public relations–publicity efforts. The Committee on Public Relations held meetings periodically during the year.

COMMITTEE ON REGISTRATION FOR ENGINEERS

During the past 2 or 3 years this committee has compiled articles on registration and development of professional attitudes. This year a pamphlet has been issued to answer questions on the desirability of registration as a professional engineer. This pamphlet was based on articles previously appearing in *Electrical Engineering*. It was not only approved by the Committee on Registration but by the Committee on Student Branches and has been distributed through the Branches to the senior electrical engineering students.

COMMITTEE ON RESEARCH

During 1953, the main work of the committee was that in connection with preparation of a series of conference papers for presentation at the Winter General Meeting in New York. As a result of the efforts of the committee, five papers were organized and presented on January 20. The chairman expressed surprise and gratification at the interest shown by members attending the

Winter General Meeting as evidenced by the turnout for the session. The room provided proved surprisingly inadequate to take care of the people who wished to attend. During the entire session which lasted until 5:15 p.m., there were standees varying in number from 30 to 50.

It is the chairman's feeling that through this action the Committee on Research has signified its intention to play an active role in the affairs of the Institute, and by the controversy which has been stirred up by some of the material presented, it would likewise appear that there is room for such activity. Clearly, when strong differences of opinion are held by competent individuals, it is apparent that problems exist which should be dealt with and solved if possible.

For the forthcoming year, the committee has planned to follow through with its general program, the objective of which is to discover those areas in which research needs to be done in order that the electrical industry may continue to serve its customers better and likewise to continue to expand. The committee proposes to move in the direction of this objective during 1954 in two ways: First, by encouraging AIEE Sections throughout the country to schedule papers and talks on research. In this connection, the committee is offering to help the divisions obtain qualified speakers of national reputation. Second, a subcommittee is being appointed on which will be representatives of the electrical utilities, the manufacturers of electric equipment, and the universities. This subcommittee has been assigned the task of exploring those areas in the industry which appear to be weak or lacking in research and in which it can be shown that research could make real contributions. Assuming that the subcommittee is successful in this search, it is proposed for the 1955 Winter General Meeting to sponsor a series of papers relating to specific areas which are felt to be those in which additional research or new research might prove profitable.

COMMITTEE ON SAFETY

During the past year, the Committee on Safety continued to sponsor a safety session at all General meetings and, through the liaison members, insure that electrical safety received increased attention at District, conference, and Section meetings. In addition, it has formulated two projects that will be, when completed, of major importance in planning future fields of activity for the committee. These projects are concerned with promoting a standardized and comprehensive method of reporting, first, fires, explosions, etc., initiated by electricity; and second, injuries or fatalities resulting from electrical contact. The committee feels an analysis of such information would be exceedingly valuable in directing, not only the committee's activities, but also as basic information to be passed on to the various technical committees for their information.

The several general sessions sponsored by the committee have been productive of many outstanding papers, as determined by the discussions and the continuing requests for copies of the papers. The forum discussion at the Summer General Meeting brought together in summary form papers describing the various organizations interested in electrical safety. It listed the name, the organization responsibilities, and the field of electrical safety in which the organization was interested. This information should do much in developing co-operation and co-ordination between the various groups interested in the several phases of this subject. The 1954 Winter General Meeting panel discussion of leakage currents did much to clarify this subject and to develop a base from which progress could be made to acceptable and practical standards of safety in this respect. Another paper of note was one covering "Safety in the Utilization of Electricity on the Farm" by E. H. Smith. Following the presentation at the Fall General Meeting, many requests were received from individuals, farm groups, and high schools in the farm area for copies of this paper and for permission to reprint it in whole or in part in the various farm publications.

The liaison activities carried on by representatives from the technical divisions continue to show outstanding progress in initiating and integrating the theme of electrical safety in the activities of their various committees. They continue to explore and suggest to their committees timely and related safety papers for presentation. The results of this activity have been reflected in the increased number of papers on safety presented at technical sessions and District meetings. Also as a result of this liaison activity, the Committee on Education and the Committee on Safety are scheduled to sponsor jointly a session on electrical safety in the near future.

The special project groups continue to make progress on several long-term projects. Included among such projects are: an authoritative AIEE reference covering the physical effects of electrical shock; a field-type defibrillator for ventricular fibrillation resulting from electrical shock; and the new group concerned with standardized reporting of cases of electrical fires and electrical shocks. Two of the special projects were considerably advanced by the committee's work during the year. The first, concerned with co-operating and co-ordinating this committee's work with that of other organizations in the same field, was started with the forum discussion at the 1953 Summer General Meeting and will be actively carried forward by the appointment of a committee member responsible for exchanging information with each such organization. The second project was one of bringing up to date the "1930-1941 Bibliography on Electrical Safety." This will be ready for presentation at the 1955 Winter General Meeting.

SECTIONS COMMITTEE

During the past year two new Sections were organized bringing the total to 100. These were the Susquehanna Section and the New Hampshire Section. The Susquehanna Section, approved in June 1953, had been the Lancaster-York Subsection of the Maryland Section. The New Hampshire Section was approved by the Board of Directors in September 1953.

Subsections have been formed at Piedmont by the South Carolina Section and in Western North Carolina by the North Carolina Section. Additional Subsections are under consideration at Idaho Falls and in Vermont. Additional Sections are under consideration at Honolulu, Puerto Rico, Quad Cities, and Savannah River. Sections which may be approved at the June meeting are Lima and Western Michigan. Territorial additions to the Susquehanna Section were approved in January 1954.

The committee held an interim meeting during the Winter General Meeting with attendance by representatives from the Sections as well as officers and District secretaries. General affairs of the Institute were discussed from the standpoint of the Section. Minutes of this meeting were circulated to all Sections. At this meeting the establishment of a certificate was recommended, which certificate would be prepared with appropriate signature by the Institute Secretary, transmitted to the District Vice-President for his signature, and then on to the Section for presentation at the beginning of each fall season to the past chairman of the Section. These certificates will first be made available for the chairman of the 1953–54 year, but will later be available for presentation by the Sections to the previous past chairmen.

A resolution prepared by the Schenectady Section regarding action towards a unity organization was unanimously passed on to the Board of Directors.

A recommendation was made that travel funds to the District Branch Prize Paper Contest be approved for District Vice-President, District secretary, and District chairman of the Committee on Student Branches in addition to the contestants in the prize paper contest.

Table VIII. Section, Subsection, and Technical Group Statistics

	For Fiscal Year Ending April 30					
	1949	1950	1951	1952	1953	1954
Sections						
Number of Sections	85	87	89	94	97	100
Number of meetings held	1,613	1,674	1,728	1,762	1,793	1,942
Total attendance	131,936	141,905	126,221	128,637	135,581	135,049
Subsections						
Number of Subsections						59
Number of Subsection meetings						416
Total attendance						16,495
Technical Groups						
Number of technical groups						116
Number of technical groups meetings						473
Total attendance						30,038
Joint Meetings of Sections						
Number of joint meetings						28
Total attendance						2,027

At the Summer General Meeting in 1953 discussion was held on registration of engineers, membership, transfers, Student Branches, Section organization and management, technical groups, prize paper competition, Subsections, publicity, Section finances, educational courses, student guidance, special technical conferences, etc. A great deal of interesting discussion took place which has been a real benefit to the Section officers for the past year.

The Section Growth Awards were made for the fourth time at the Summer General Meeting in Atlantic City. These were reported in the December issue of *Electrical Engineering* (*p 1124*) and showed awards of a gavel, suitably inscribed, to the Schenectady Section and the Spokane Section for the larger than average Sections and the smaller than average Sections respectively for the year 1952–53. Second prize certificates were awarded to the Maryland Section and the Cincinnati Section in the large and small Sections respectively.

STANDARDS COMMITTEE

The co-operation between the technical committees and the Standards Committee has been aided considerably by the practice outlined in the new Standards Manual, whereby technical committees are invited to appoint a liaison representative to the Standards Committee for the purpose of keeping the Standards Committee informed of the activities of the technical committees relating to standards and of keeping the technical committees informed both of the discussions of standards work and of appointment of representatives to American Standards Association (ASA) committees or joint committees with other organizations.

Most of the technical committees have appointed the vice-chairmen as liaison representatives to the Standards Committee and this has enabled the new technical committee chairmen to become thoroughly familiar with Institute standardization practices.

Some of the technical committees that are particularly active in standards work have expressed concern over the lack of information on ASA standardization activities brought back to the technical committees by the Institute's representatives, but this appears to be a subject for action by the technical committees themselves rather than by the Standards Committee, although the technical committee chairmen concerned have been informed that the Standards Committee would give sympathetic consideration to any proposed modification in appointment practice which the technical committees might suggest, so that the members of the Institute who are best informed in a particular field would continue to exert a proper influence over American Standards.

Only one meeting of the Standards Committee was held during the administrative year of 1953–54, with another meeting scheduled the latter part of April, much of the work being done through correspondence.

The following standards work was completed:

An Insulation Maintenance Guide for Large Rotating Machinery.

A revision of AIEE Standard Number *1*, "General Principles Upon Which Temperature Limits are Based in the Rating of Electric Machines and Apparatus," and Number *1-C*, "Test Code for Evaluation of Systems of Insulating Materials for Random Wound Electric Machines," both by Standards Co-ordinating Committee Number *4*.

A revision of Standard Number *4*, "American Standard for Measurement of Voltages in Dielectric Testing," by the Subcommittee on Instruments and Measurements, ASA *C68*.

Number *504*, "Proposed Test Code for Carbon Brushes" by Joint Subcommittee on Carbon Brushes, composed of AIEE Committee on Rotating Machinery, AIEE Committee on Air Transportation, and a NEMA technical committee of the Carbon Section.

The Standards Committee reviewed and accepted as an American Standard, under ASA procedure, Underwriters' Laboratories Standard for Flexible Cord and Fixture Wire and agreed to serve as cosponsor with ASME of ASA Committee *Y32.2* on "Graphical Symbols for Electrical Diagrams."

UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

The annual meeting of the International Electrotechnical Commission (IEC) was held in Opatija, Yugoslavia, June 22 to July 4, 1953. Fifteen technical committees and subcommittees and the Committee of Action held meetings at which there were 315 delegates present, representing 17 countries. The delegation of the U.S. National Committee (USNC) numbered 15, including all its officers, as follows: R. C. Sogge, General Electric Company (president, USNC); P. H. Chase, Philadelphia Electric Company (vice-president, USNC); Vice Admiral G. F. Hussey, Jr., American Standards Association (treasurer, USNC); J. W. McNair, American Standards Association (secretary, USNC); L. J. Berberich, Westinghouse Electric Corporation; C. C. Chambers, University of Pennsylvania; V. M. Graham, Sylvania Electric Products, Inc.; M. H. Hobbs, Westinghouse Electric Corporation; E. M. Hunter, General Electric Company; J. F. McClenahen, General Electric Company; B. Lazich, Westinghouse Air Brake Company; Leon Podolsky, Sprague Electric Company; August Schmidt, Jr., General Electric Company; E. F. Seaman, Department of the Navy; H. P. Westman, International Telephone and Telegraph Company.

At the meeting of the Committee of Action, which is the executive committee of the IEC, and is charged with administering its affairs, several matters of policy were taken up. Questions considered included the degree of agreement between the national standards of the different member countries and the corresponding IEC standards; obstacles to international trade formed by regulations concerning electric equipment; inclusion of references to tropical and subtropical atmospheric conditions; and harmonization of IEC work with that of other international organizations such as the International Commission on Illumination. All of these were studied with care.

A proposal by the United States concerning co-operation between IEC Technical Committee *29* on Electro-Acoustics and International Organization for Standardization (ISO) Technical Committee *43* on Acoustics was accepted and passed on to the ISO for its acceptance. This proposal makes IEC Technical Committee *29* responsible for all electro-acoustic standards, while ISO Technical Committee *43* is confined, for the present, to questions of standards of musical pitch. This proposal was subsequently accepted by the ISO council.

Some measure of the increased activity of the Commission during the year is the fact that six international recommendations were either printed or are in the course of being printed; 19 international recommendations were circulated to the member countries for approval under the "Six Months' Rule," and five additional documents were reviewed under the "Two Months' Rule."

Thirty-eight technical committees of the IEC are now working on international electrical standardization problems. At the Opatija meetings action was taken on symbols for rotating machines, ceramic capacitors, a specification for fixed paper capacitors, and a new subcommittee was set up to deal with the standardization of high-frequency (coaxial) cables and high-frequency connectors.

Work is going forward on a proposed specification for a-c circuit breakers, and a proposed recommendation for the unit testing of circuit breakers for making and breaking capacity to supplement the specification was completed. Both of these will be submitted to the national committees of the IEC for approval by letter-ballot. A comprehensive specification for a-c power circuit breakers for world-wide use is being prepared, chapter by chapter.

Agreement was reached on a draft specification for tests on impregnated paper-insulated lead-covered cables for voltages of 10 to 66 kv which is now out to letter-ballot of the national committees.

A draft specification for ionic converters has also been drawn up.

Further work was done on a new document covering tubular fluorescent lamps, and consideration was given to colors and color ranges and ballasts for fluorescent lamps. Much progress was made toward an international understanding on the difficult subject of colors and color ranges.

Work was done on standardization of starters for fluorescent lamps, dimensions of ballasts, and methods of measurement.

A new subcommittee was set up to cover lighting fittings, which was to work in close collaboration with the International Commission on Rules for the Approval of Electrical Equipment (CEE) in the preparation of a specification for lighting fittings for tungsten filament lamps on which the CEE is already at work.

Detailed consideration was given to the second draft of a specification for lightning arresters of the type incorporating nonlinear resistors, and considerable progress was made with the sections dealing with definitions, ratings, and methods of test, but further consideration must be given to the values of residual voltage.

A new scope for the Committee on Electronic Tubes was approved and this committee is now responsible for all electronic tubes, except X-ray tubes, as well as for solid-state devices such as crystal diodes, transistors, and the like, including the electrical and mechanical characteristics of these devices as well as the holders in which they are used. Further consideration will be given to the dimensions of electronic tube and valve outlines, gauging practice for tube bases, measurement of the characteristics of tubes, and minimum published data for tubes.

About 300 electrical technical experts from the 30 IEC member countries and about 400 from the United States are expected to attend the Golden Jubilee meeting of the IEC to be held on the campus of the Univer-

sity of Pennsylvania, Philadelphia, September 1–16, 1954. P. H. Chase of the Philadelphia Electric Company is chairman of the General Committee in charge of arrangements. The chairmen of the subcommittees of the General Committee are Dr. A. V. Astin, Washington trip; Dr. C. C. Chambers, housing and hotel; V. L. Cox, technical trips; V. M. Graham, program; T.E. Stieber, entertainment; R. H. Stier, transportation; Dr. S. R. Warren, Jr., facilities.

A Finance Committee, under the chairmanship of W. L. Cisler, president of the Detroit Edison Company, is raising the necessary funds for the Jubilee. The members of this committee are M. F. Balcom, Sylvania Electric Products, Inc.; A. C. Monteith, Westinghouse Electric Corporation; General W. H. Harrison, International Telephone and Telegraph Corporation; W. V. O'Brien, General Electric Company; R. G. Rincliffe, Philadelphia Electric Company; J. F. Roberts, Allis-Chalmers Manufacturing Company; E. J. Schwanhausser, Worthington Corporation; J. K. Sprague, Sprague Electric Company.

The delegates will hold 240 morning and afternoon sessions in which they will work on international standards in the fields of electric light, power, and communications.

The United States holds the secretariat for five of the technical committees which will meet in Philadelphia. They are steam and hydraulic turbines, internal combustion engines, letter symbols and signs, and lightning arresters.

The president of the IEC is Dr. H. S. Osborne, who is the fourth American to hold this office since the founding of the IEC in 1904.

The Philadelphia meetings will include an all-day Jubilee celebration on September 9 commemorating 50 years of IEC. Speakers will be Lord Waverly, chairman of the Port of London Authority and past president of the British Standards Institution; Dr. Hakan Sterky, head of the Swedish Communication System; P. P. Ailleret, director of Electricité de France, and Dr. Lee A. DuBridge, president of the California Institute of Technology.

COMMITTEE ON STUDENT BRANCHES

The Committee on Student Branches, with the aid of the President, the Vice-Presidents, the counselors, and with a great deal of able assistance from Headquarters, has been actively engaged in a program to assist the Branches in improving their operation and to stimulate interest in AIEE in the colleges.

Charters, consisting of framed certificates signed by the President and Secretary, showing the date the Student Branch was authorized, were sent to each Branch in September.

In October, a supply of folders entitled "The AIEE Student Member" was sent to each Student Branch. This folder, which contained an invitation from the President to each electrical engineering student to join AIEE, explained what AIEE is, how it works, how to join AIEE, and briefly described the publications and the benefits to be derived from membership in AIEE. In January, another folder entitled "14 Practical Ways to Advance" was printed and sent to the colleges. This folder outlined 14 major reasons why an electrical engineering student should become an AIEE Student member.

Another service which the committee

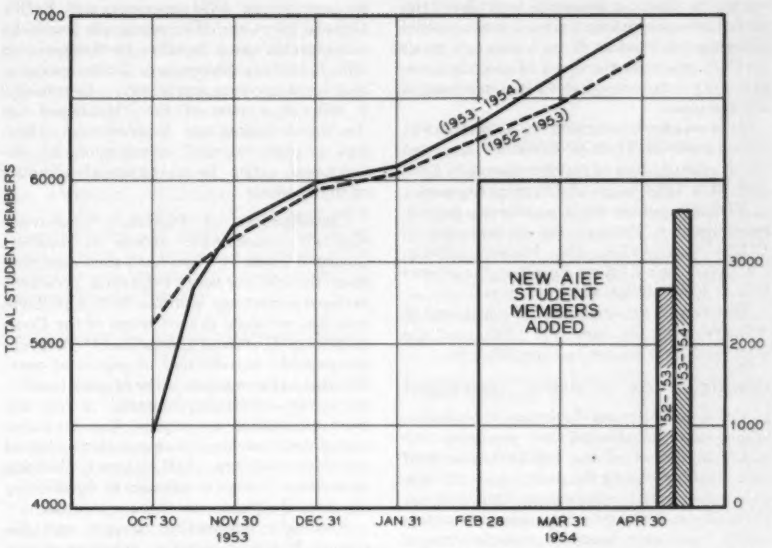


Fig. 3. Total AIEE Student members at the end of each month: October 1953–April 1954

rendered to the Student Branches was the distribution in the colleges of an article entitled "Registration as an Engineer" prepared by the AIEE Committee on Registration for the purpose of informing senior electrical engineering students about procedures for becoming registered and other related information.

Another important project was the development of a plan whereby a number of major industries will arrange to make some of their best speakers on interesting technical subjects available for Student Branch meetings. This plan was recently placed in effect and should be in full operation next fall.

In February, the committee inaugurated a monthly program for directing attention to articles in *Electrical Engineering* of probable interest to students. This consisted of preparing a poster showing selected pages of the current issue of *Electrical Engineering*. Several copies of the posters were sent to the Branches each month for posting on their bulletin boards.

Since last September, one or more letters every month have been sent to all of the counselors, giving information and advice on Student Branch matters.

During the past 2 years, the committee has been developing a manual for the guidance of counselors and Student Branch officers. This work has been completed and the printing of this Student Branch manual has been authorized for distribution to the Branches on or about September 1.

Upon recommendation of the Sections Committee and the Committee on Student Branches, the Board, at its meeting on January 20, authorized and appropriated the necessary funds for District Prize Paper Contests so that the District Vice-President, the District secretary, and the chairman of the District Committee on Student Activities may receive travel allowances for attending these contests.

A subcommittee has been engaged in a study of the question of providing Affiliate Student membership and Affiliate Student Branches in electrical engineering schools which are not accredited by ECPD.

Vice-Presidential visits to the Branches have been encouraged. Their visits have helped to establish the spirit and the enthusiasm that are so necessary for a Branch to serve the students adequately and to provide the students with all that AIEE can offer them in developing their engineering careers.

The best evidence of the effectiveness of the efforts of the Institute officers, counselors, and the Committee on Student Branches is to be seen in Fig. 3 which shows that at the beginning of the year there were 633 fewer Student members than at the beginning of 1952–53, while at the end of 1953–54 there were 122 more than last year. Table IA in the report of the Board of Examiners shows an even more encouraging trend. This is also depicted in Fig. 3. There were in all 951 more new Student members added in the past Institute fiscal year than during the last previous period. These figures tend to show that what was recognized at the beginning of this year as the Institute's most pressing problem has apparently received some effective attention. However, the Com-

Table IX. Student Branch Statistics

	For Fiscal Year Ending April 30					
	1949	1950	1951	1952	1953	1954
Number of Branches	129	130	133	132	133	135
Number of meetings held	1,405	1,318	1,303	1,178	1,250	1,117
Total attendance	105,290	81,815	63,369	49,324	45,895	49,213

mittee on Student Branches feels that little more than a beginning has been made toward bringing the Student Branch program to its possible place in the field of electrical engineering education and in the structure of the Institute.

As a service to engineering educators the Committee on Student Branches arranged for the distribution of reprints from the April and May 1954 issues of *Electrical Engineering* to all deans and electrical engineering department heads. Through the co-operation of ECPD and AIEE, Dr. Hazen's article, "A Letter to a College President," was sent to over 1,000 college administrators.

Two committee meetings were held: one in Atlantic City on June 17, 1953, and the other in New York on January 20, 1954.

COMMITTEE ON TECHNICAL OPERATIONS

The Committee on Technical Operations, which was established to supervise the technical affairs of the Institute, has held four meetings during the past year. At these meetings, matters concerning technical aspects of the Institute were reviewed, among which were such items as co-ordination of division activities, procedures for acceptance of technical papers, endorsement of formation of new technical committees, and co-operative activities with other technical societies. The following subjects have been considered during the past year.

Handbook of Information for Authors. A revision of the old "Information for Authors" has now been completed, and the new "Author's Guide" (1953) is available for distribution. This guide is in a new format, and is divided into three parts: 1. For the Author; 2. For the Typist; and 3. For the Draftsman. With the explanatory material accompanied by examples, it is believed that the new guide will be of greater help to authors. It is intended that the pamphlet be distributed to prospective authors by the chairmen of the several technical committees.

Technical Sessions Guide. In the past the procedures to be followed by presiding officers and speakers at technical sessions have been described in some detail in a leaflet, "Conduct of Technical Sessions." This leaflet has been completely revised, and a new format entitled "Technical Sessions Guide" is now ready for printing. It is expected that the new guide will be available for use at the 1954 Summer and Pacific General Meeting. The new guide should be considerably easier to follow by the presiding officer, author, discusser, projector operator, and local meeting committee. Eventually, it will be a part of the "Handbook for Technical Committee Operations," which will provide essential information for co-ordinated action in all technical activities of the Institute.

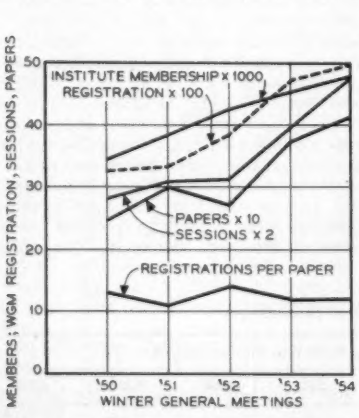


Fig. 4. Winter General Meeting statistics for the past 5 years, 1950 through 1954

Classification of Papers. "Conference papers," which have grown in numbers during the past 10 years until they now total more then 50 per cent of the total presented at General meetings, continue to be a problem that has occupied the attention of the Committee on Technical Operations. To avoid the possible introduction of papers of questionable value, such as those of poor quality, or purely advertising material, a rule has been established to require that technical committee chairmen, or responsible technical committee officers, shall approve abstracts or outlines 75 days in advance of the meeting at which the papers are to be presented.

Although considerable thought and discussion has been given to selecting a new name for such papers, there has not been agreement on a substitute, and the title "conference paper" will be continued.

Publication of Conference Papers. The Publication Committee has been studying the problem of how to make conference papers available to the membership, particularly to those who are unable to attend the meetings, and to obtain copies from the limited supply usually furnished by the authors. On the recommendation of the Publication Committee, the Committee on Technical Operations voted to endorse the policy of duplicating conference papers that are received from authors prior to a 60-day closing date, and making these available for sale to the membership either by mail order prior to the meeting, at the meeting, or by mail order for a reasonable time after the meeting. Authors who fail to meet the 60-day closing date may duplicate their own papers, to be turned over to the Institute for sale and distribution.

Papers by Nonmember Authors. As a result of the studies made by a special subcommittee of the Committee on Technical Operations, and as approved by the parent committee, presentation and publication of *Transactions* papers by nonmember authors have been made subject to approval by the pertinent division chairman. A code of principles has been prepared and approved by the Committee on Technical Operations, this code to be used by the division chairmen in approving or rejecting such nonmember *Transactions* papers.

Special Technical Conferences. Special technical conferences have continued to be an important part of Institute activities. The Committee on Technical Operations has now authorized the technical divisions to approve such conferences in their respective fields, under the provisions of a manual prepared and approved by the Committee on Technical Operations. Authorization has also been granted to the divisions to accept papers for presentation at these conferences as official *Transactions* papers. The same procedure for closing dates, reviews, and approvals shall apply to special technical conferences as to other authorized meetings, such as General and District meetings of the Institute.

Table X. Papers Sponsored by Technical Divisions and General Committees

Classification	Transactions Papers	Conference Papers
Power Division	234	126
Science and Electronics Division	78	190
Communication Division	51	61
Industry Division	41	151
General Applications Division	12	47
General Committees	0	27
Totals	416	602
Grand total		1,018

Award of Institute Prizes. Procedures for the award of Institute prizes have been under study by the Committee on Prize Awards. A revised set of "Prize Rules for AIEE Papers" was presented to the Committee on Technical Operations at its January 1954 meeting and endorsed by that committee.

Division Committees. The Committee on Technical Operations has continued its principal function, namely, that of serving as the co-ordinating agency for the technical activities of the five division committees. Although most of the co-operative work of the divisions is accomplished without the necessity of specific directives from the Committee on Technical Operations, during the past year several items have been considered. Among these are a new form to assist in the review and evaluation of technical papers, endorsement of elevation of the Petroleum Industry Subcommittee to full technical committee status, clarification of scopes of technical committees, and the transfer of such subcommittees as seems appropriate. Estimates of papers to be available for future meetings have been discussed, and the matter of their presentation, particularly scheduling, reviewed. Reports of the several divisions are given elsewhere in this report.

COMMITTEE ON TRANSFERS

During the past year, the primary objective of the Committee on Transfers has been to disseminate as widely as possible throughout the membership acquaintance with the new requirements for the various grades of membership in Institute which became effective in 1951 and which were summarized in the article, "A Redefinition of AIEE Membership Grades," by C. W. Franklin, chairman of the Board of Examiners (*EE, Apr '53, pp 281–4*). Particular emphasis was laid by the committee on the matter of transferring from one grade of membership to another, with special attention being directed to transfers from Member to Fellow grade.

In this connection, the subject was presented to the Section delegates at their conference during the Summer General Meeting at Atlantic City in June 1953, and again to the Sections Committee during the Winter General Meeting in New York in January 1954. The committee has also prepared a pamphlet entitled "A Guide to Transfers of Membership," which was issued during March 1954 to all Section officers and Section transfers committees.

During the calendar year February 1953 to February 1954, 492 Associate Members were transferred to Member grade and 45

Members were transferred to Fellow grade.

The committee held one meeting during the year at the Winter General Meeting in New York in January 1954. The members present displayed great interest in the work of the committee and undertook to carry their enthusiam for transfers work back to the Sections in their respective parts of the country.

TECHNICAL DIVISIONS AND COMMITTEES

Communication Division

COMMUNICATION DIVISION COMMITTEE

In accordance with the bylaws, the Communication Division Committee has been serving as a co-ordinating and encouraging agency for its technical committees. It has accomplished its function primarily by committee meetings held at each of the Summer, Fall, and Winter General Meetings. Experience during the year is convincing that the committee's own area of operation is well defined, and that all of its constituent technical committees also have a clear field of . ctivities. The division has been considering a proposal to establish a new constituent Committee on Information Theory, but has not yet reached final decision on this proposal. Active liaison has been maintained, of course, with both the Committee on Research and the Committee on Safety.

The individual reports of the division's technical committees, which follow, give a more detailed and complete picture of the activities in each branch of the fast expanding communications technology.

COMMITTEE ON COMMUNICATION SWITCHING SYSTEMS

The committee attempts to develop programs having a common theme which will appeal to a particular group representing one of the several areas of interest in the field of communication switching. It is not always possible to do so and at the same time remain faithful to the responsibility of reporting promptly the new developments in active areas. Nation-wide dialing is currently of particular interest and papers on this subject from the independent telephone companies are especially welcome. The committee also encourages contributions dealing with the theoretical and abstract aspects of switching.

During the year, three committee meetings were held, and three technical sessions were sponsored, one each at the Summer, Fall, and Winter General Meetings. The session at the Summer General Meeting included two papers on mathematical methods of switching circuit design and a paper on the use of transistors in a telephone switching system application. Emphasis was placed upon components of communication switching systems at the Fall meeting. The papers covered a new component for switching, an application of an older device which is gaining in popularity in switching circuits, automatic testing, and a unique method of assembly. Most of the sessions relate to telephone switching systems but at the Winter General Meeting a report was made on a printing telegraph switching center for the military. Other papers presented new concepts regarding the theory of switching.

The committee has also made plans to sponsor a session at the Summer and Pacific General Meeting. It will include a report on experiences with the application of toll-dialing equipment and a paper on a communication switching system for state highways.

Recent growth in the industry and advancement of the art has given rise to new items and technical terms. The committee has instigated preliminary work on the preparation of a glossary of communication switching terms and phrases. It is expected that this work will result in a publication for the aid of new people in the industry and to promote standardization.

COMMITTEE ON RADIO COMMUNICATIONS SYSTEMS

The committee has experienced some difficulties in obtaining suitable papers for presentation at meetings of the Institute and for inclusion in its publications. This matter has been given special consideration and was the subject of discussion by the committee. The difficulty is believed due in part to the activities of the IRE, since the efforts of that organization to obtain technical papers places it directly in competition with the AIEE in so far as the field of radio communications is concerned. Another contributing factor appears to have been the fact that few of the engineers associated with radio manufacturing firms and radio laboratories are members of the AIEE, thus increasing the problem of getting papers suitable for publication. The recent broadening of the editorial policy of the AIEE concerning papers by nonmember authors will prove of some assistance in this connection. However, the committee's opinion is that much more should be done along the lines of developing interest and membership in the AIEE among the engineering personnel of companies engaged in radio manufacturing and development work. Also, it is thought that an effort should be made to co-ordinate the activities of the AIEE and the IRE in order to lessen the competitive situation that presently exists.

Despite these problems, the committee has received enthusiastic support in its activities and plans for the Summer and Pacific General Meeting at Los Angeles and contemplates two technical sessions devoted to papers on radio communications systems matters.

COMMITTEE ON TELEGRAPH SYSTEMS

At the Winter General Meeting two interesting and well attended sessions were sponsored by this committee. One of these was in the facsimile field and consisted of three papers on continuous-feed scanners and recorders. At the other session papers were presented on a new portable electronic telegraph transmission measuring set, an international printing telegraph exchange system, and two new lines of printing telegraph equipment. The last-mentioned equipments, developed and introduced by two separate manufacturers, are smaller and superior in speed capabilities as compared to machines hitherto available. A committee meeting was also held at which various possible subjects for papers to be presented at future meetings were discussed. Plans of the committee include covering operation at speeds much higher than those now in use as well as other advances in the fields of telegraph and facsimile systems. Also, efforts are under way toward obtaining some papers relating to recent progress on telegraph systems in Canada for presentation at the next Winter General Meeting.

COMMITTEE ON TELEVISION AND AURAL BROADCASTING SYSTEMS

Continuous attention was paid to color television by the committee, and a total of 12 papers at the three national meetings brought the developments on this subject to the attention of the membership.

In monochrome television there was an impressive increase in the number of uhf broadcasting stations, accompanied by technical advances in higher-powered transmitters. These topics and also improvements in receivers were described in meeting sessions.

The attention of the committee was also directed toward 2-channel stereophonic broadcasting, utilizing the AM and FM transmitters of the particular station. The use of magnetic recording has increased greatly, and likewise claimed the attention of the committee. On both subjects groups of meeting papers were arranged.

Toward the latter part of the year the committee made a beginning on the preparation of a program on the perfection of color television, for the purpose of offering this as one of the programs of a series to be called "Creative Frontiers"; these programs are planned for television presentation in order to acquaint the general public with the many technical advances of the present day.

COMMITTEE ON WIRE COMMUNICATIONS SYSTEMS

The committee sponsored technical sessions at the Summer, Pacific, and Winter General Meetings, and committee meetings were held coincident with these meetings. Arrangements have been completed for sponsoring sessions at the forthcoming Summer and Fall meetings.

Much emphasis in the past has been placed on new types of systems employed for wire communication systems, and papers were presented covering new short-haul carrier telephone systems, and their application. In addition, several papers were presented this year covering new types of cables employing polyethylene-insulated conductors. Much interest is being shown in the use of such cables in areas with high lightning incidence because of their higher breakdown voltage characteristic. Other reductions in maintenance costs are also expected to result from the new type of insulation.

As a result of increasing interest in telephone service in rural areas, two papers were presented; one of these covered the work being carried on by the Rural Electrification Administration, and the other recent advances in providing rural subscriber service in the Bell System. Further papers on this subject are in prospect.

General Applications Division

COMMITTEE ON AIR TRANSPORTATION

The annual business meeting of the committee was held on October 2, 1953, with 26 members present. It was decided to sponsor two technical sessions at the Summer and Pacific General Meeting and to hold the Annual Aircraft Electrical Equipment Conference in conjunction with the Fall General

Meeting in Chicago, Ill., October 15–21, 1954. Reports given by the five subcommittee chairmen indicated that their committees were active in preparing test codes, procedures, and guides for use by the electrical sections of the aircraft industry.

The newly formed Subcommittee on Dielectric Testing Procedures for Aircraft Electric Equipment and Insulating Materials began to function by outlining a 3-phase program. Phase 1, the survey of present methods in use by both domestic and foreign companies, the gathering of research material presently available from airframe manufacturing companies and military research laboratories, and the instigation of special research projects, is well under way. Phase 2 will be the co-ordination of all this information. Phase 3 will be the writing of a tentative dielectric test code. The tentative code is scheduled for presentation for committee approval in October 1954.

The Subcommittee on Aircraft Electric Rotating Machinery has completed AIEE Test Code Number *800*, "D-C Aircraft Rotating Machines." It is being published as an official test code. A generator characteristics project which is an attempt to standardize the type of name-plate data and characteristic curves for aircraft generators is fairly complete and will be presented for publication soon. Proposed test codes for 400 cycles per second a-c machines have been submitted to the Committee on Air Transportation for approval.

The Subcommittee on Rotating of Airborne Electric Apparatus has decided to devote present efforts to the thermal rating of rotating equipment. The subcommittee plans to present the accomplishments of its working groups by means of technical papers in at least one session, devoted entirely to thermal ratings, at the Fall General Meeting.

The Subcommittee on Aircraft Electric Systems has recommended to the Standards Committee that the nominal system voltages of 14 to 28 volts direct current be specified in AIEE *700* since 12 and 24 volts direct current is inconsistent with current aircraft practice. Revision of AIEE *750*, "Aircraft Systems Guide," is partially complete. It is believed the assignment will be complete by October 1954.

The Subcommittee on Aircraft Control, Protective Devices, and Cables has completed two test codes, "Carbon Pile Voltage Regulators for Aircraft" and "Aircraft Circuit Interrupter Devices." They have been referred to the Standards Committee for publication on a 1-year trial basis.

COMMITTEE ON DOMESTIC AND COMMERCIAL APPLICATIONS

The technical activities of the committee have been carried on by four subcommittees during the past year.

Subcommittee on Electric Space Heating and Heat Pumps (East) sponsored a technical session at the Winter General Meeting, which was attended by approximately 200 people, showing the continued popular interest in these subjects. The papers presented covered installation and application problems largely from a customer and utility viewpoint, with a brief discussion of manufacturers' design problems. The committee has not had much success in obtaining more than a small number of technical papers as compared with discussion-type conference papers, although good technical progress has been made in this field during the last year. It is hoped that as more manufacturers enter the field more technical information can be presented in the form of *Transactions* papers to help record the advances in the art.

Subcommittee on Electric Space Heating and Heat Pumps (West Coast) is sponsoring two technical sessions at the Summer and Pacific General Meeting this June. At least one *Transactions* paper and six or seven conference papers will be presented on these subjects. As this is the first technical session in several years on the West Coast there is a lot of general interest in these subjects. The West Coast Subcommittee is building up and stabilizing its program. The wide-spread local interest in space heating and heat pumps makes the use of two subcommittees worth while at present. As with the committee in the east, there is a lack of good *Transactions* papers at present.

Subcommittee on Domestic Appliances holds the fifth Appliance Technical Conference at Chicago in May on the subject, "Performance Testing and Standardization." This conference is jointly sponsored with the AIEE Chicago Section. This series of conferences held with the aid of the local AIEE Sections has been very successful and it is planned to continue them as long as the enthusiastic support of the participants continues and grows as it has in the past.

Subcommittee on Farm Electrification, in the fall of 1954, is planning to hold a special technical conference at Lafayette, Ind., co-sponsored with the local AIEE Section. At this writing, plans are not complete, but it is hoped to discuss the many problems raised by the large growth of electric usage on the farms during the past few years and the large potential market for electricity in this field. This is the first conference organized by this committee since it participated in the National Farm Electrification Conference in 1952 in Detroit, Mich. The discontinuance of the meetings enables the committee to contribute in this field.

General. A Standards Committee representative has been appointed from the committee to review possible activities. No standards have been initiated as yet. Liaison with other AIEE committees has not taken place. One particular request was unfilled for lack of a committeeman who could serve on both committees.

The scope of the Committee on Domestic and Commercial Applications in the future may be extended, particularly in the fields of adequate wiring and domestic air conditioning, and it stands ready to consider other areas as suggested.

COMMITTEE ON LAND TRANSPORTATION

In the field of heavy electric traction, the placing in operation of a quantity of rectifier-type multiple-unit cars is important and several recent Institute papers have been presented on the features and probable performance of this latest development in railroad motive power.

In the diesel-electric field, there have been refinements and improvements, which are permitting somewhat larger horsepower outputs from engines and generators having approximately the same weights and dimensions as in the past. Developments in control and excitation have also been made. Institute papers on these topics have been read during the past year.

The practice of devoting a technical session to the several aspects of one subject has enhanced the interest in the sessions.

A member of the Committee on Land Transportation attended the meetings of the IEC at Interlaken, Switzerland, June 8–11, 1953. Thirty-five representatives from eight nations were in attendance.

The Europeans have been co-operating on rules and standards of the IEC for many years, and the attendance of United States representatives at the last two meetings has been welcomed and appreciated by the European representatives.

Prior to the meeting at Interlaken, the United States submitted certain recommendations for changes in the IEC rules and standards, particularly with the idea of greater conformity to AIEE Standards. A number of these recommendations were accepted, and others held over for consideration at future meetings.

At the next IEC meetings, to be held in Philadelphia, September 1–16, standards for electric equipment for diesel locomotives will be on the agenda.

Following the IEC meetings at Interlaken, the Land Transportation Committee member represented the President of the AIEE at the ceremonies celebrating the 100th anniversary of the technical school of the University of Lausanne.

AIEE Committee *11* (ASA *C-35*) has initiated revision of Standard *11* (ASA *C-35.1-1943*) and is progressing with this assignment. A subcommittee, which is handling the details of this revision, has met and agreed upon a set of principles to guide its work. Limits for class *H* insulation will be introduced, the text will be shortened as much as practicable, and footnotes and appendixes will be eliminated.

COMMITTEE ON MARINE TRANSPORTATION

The Committee on Marine Transportation has continued its practice of meeting twice yearly to consider desirable modifications and additions to AIEE Standard Number *45*, "Recommended Practice for Electrical Installations on Shipboard." Meetings were held on May 29 and December 4, 1953.

Approved modifications in these marine recommendations, the latest issue of which is December 1951, will be included in a new issue to be dated December 1954. A new section on electrically operated galley equipment, extensive new and clarifying material on a-c switchboards, as well as numerous other modifications resulting from committee actions taken up to and including the May 14, 1954, meeting, will be incorporated in the new December 1954 issue.

Because of the growing size of a-c ship's service systems, and because of the possibility of overvoltages being produced on ungrounded a-c systems under certain operating conditions, a special subcommittee has been appointed to investigate the need for recommendations in this matter. This committee will evaluate the probability of such overvoltages, consider the advantages and disadvantages of grounding, and thus provide the basis for any necessary recommendations.

A highly successful marine session was held during the 1954 Winter General Meeting in New York. The number who attended and the extent of the discussions indicated con-

siderable interest in marine electrical matters and has encouraged the planning for future sessions. The Winter General Meeting in New York appears to be most appropriate for marine sessions, because of the concentration of marine activity and marine-minded engineers in that general area.

The Subcommittee on International Standardization has been actively preparing for the marine portion of the IEC Golden Jubilee meetings in Philadelphia in September. The AIEE Committee on Marine Transportation is the advisory group to the USNC, and the chairman of the Subcommittee on International Standardization is the technical advisor to the USNC. Numerous matters effecting electric installations on ships will be considered on an international basis in relation to a "Code on Electrical Installations on Ships" with excellent opportunities afforded for discussing and appraising the marine electrical practices of other nations. The Committee on Marine Transportation is planning to take an active part in appropriate portions of the program.

COMMITTEE ON PRODUCTION AND APPLICATION OF LIGHT

The committee met twice: during the Winter General Meeting and also during the Summer General Meeting. The summer committee meeting helped strengthen the program sponsored by the committee during the Winter General Meeting.

The topic of the day's session during this meeting was lighting maintenance. Speakers and subjects were selected to cover comprehensively the need, benefits, and methods of maintaining lighting systems in industrial plants and properties. The performance and merits of new fluorescent, mercury, and incandescent lamps were related to older designs. The increased visual comfort provided by many of the new luminaire designs was also described and illustrated.

The committee's current position relative to the technical program and to the other technical committees of the Institute was studied. This committee is not subject to the pressure of most others to secure ever-increasing program time for the presentation of submitted papers. Instead, there is sometimes difficulty in scheduling speakers for a reasonably adequate report on the progress being made in lighting and in the associated fields of infrared and ultraviolet. Good attendance at sessions sponsored by the committee indicates that the problem has been met at least satisfactorily. But as a result of such introspective analysis, closer liaison with several other committees and joint sponsorship of sessions are planned for the future. They should make the committee's contribution to the Institute's technical program more effective.

Industry Division

COMMITTEE ON CHEMICAL, ELECTROCHEMICAL, AND ELECTROTHERMAL APPLICATIONS

The committee and all subcommittees sponsored a number of technical programs with active participation by the members.

Chemical Industry Subcommittee held technical sessions at the Middle Eastern District and Winter General Meetings and will hold a session at the Summer and Pacific General Meeting.

Electrochemical Processes Subcommittee held a session at the Winter General Meeting. Two formal papers were presented followed by an open discussion led by a panel of experts on the subject, "Layout of Modern Rectifier Substations." This was the first time the committee had attempted this type of meeting and the information that was developed by the discussion aroused considerable enthusiasm, and plans are being made to hold other meetings of this type.

Petroleum Industry Subcommittee held sessions at the Summer, Fall, and Winter General Meetings.

The Board of Directors has granted the subcommittee full committee status effective at the beginning of the next fiscal year. A major program planned for the new committee is the holding of a 3-day special technical conference which will be called "Electrical Conference for the Petroleum Industry" to be held in Tulsa, Okla., September 27–29, 1954.

Electrothermal Processes Subcommittee. This subcommittee arranged and sponsored a technical session at the Middle Eastern District Meeting at Charleston, W. Va., in September 1953. This session dealt with a new type of arc furnace circuit breaker of the compressed air type and with the design and application of high-current short-circuiting switches used in electrochemical and electrothermal applications. In addition, part of the technical session was devoted to the subject of reduction of ores by electrothermic means. Plans of the subcommittee call for one technical session for 1954.

Cathodic Protection Subcommittee. The Cathodic Protection Subcommittee included in their activities for the year participation in two meetings. At the 1953 Fall General Meeting a full technical session was conducted. At this meeting subjects covered included: use of zinc and zinc-coated metals in cathodic protection work, a discussion relating to work of the Detroit Committee on Electrolysis, and the use of magnetic amplifier control for cathodic protection equipment. At the 1954 Winter General Meeting in New York, this subcommittee jointly sponsored a technical session with another subcommittee. Topics related to the session included electrical grounding and cathodic protection as practiced at a modern steel mill. Plans for this subcommittee include participation in the next Fall and Winter General Meetings.

Storage Battery Subcommittee. This subcommittee sponsored a technical session at the 1953 Summer General Meeting. The session dealt with the charge and discharge processes and characteristics of lead-acid storage batteries. The additions of inhibitors to the electrolyte were thoroughly covered. Also, the methods for selection of battery size for various discharge schedules and load changes were covered. It is believed worthwhile contributions to the art were made at this session. The material presented was later placed on a *Transactions* status and presented at the 1954 Winter General Meeting.

COMMITTEE ON ELECTRIC HEATING

Plans are being made for the second AIEE Conference on Industrial Electric Heating, to be held in Chicago, Ill., May 10 and 11, 1955, sponsored jointly by the Chicago Section and the Committee on Electric Heating. The committee met in October to do the initial planning for this conference and again in April to make all final arrangements.

The Induction and Dielectric Heating Subcommittee has continued to co-operate with the FCC in its work to control and suppress stray radiation from induction and dielectric heating apparatus.

The Technical Data Subcommittee has worked hard and long accumulating data on all phases of industrial heating, but the job has not advanced to the point where any material is ready for release.

The principal job at this time is preparing for the 1955 conference and all efforts are being directed toward making it a success.

COMMITTEE ON ELECTRIC WELDING

The fourth Conference on Electric Welding, May 19–21, in Milwaukee, Wis., was the main project of the committee for 1953–54. Five sessions on various electric welding subjects, inert gas arc, fundamental arc research, safety, instrumentation; and resistance welding, were held plus inspection trips through various industrial plants.

The committee held business meetings in Atlantic City in June, and Cleveland, Ohio, in October, during the National Metal Exposition and Fall Meeting of the American Welding Society (AWS), and during the Winter General Meeting of the AIEE in January.

Subcommittee on Fundamental Arc Research has published its new "Bibliography on High-Pressure Electric Arcs" which includes over 2,200 references submitted by subcommittee members and many other contributors. Meetings of this subcommittee were held in June 1953 and January 1954.

Subcommittee on Instrumentation for Resistance Welding continued to be very active. Three working groups studied application of various instruments for measurements required in resistance welding. Members co-operated with representatives of the AWS, NEMA, and the AIEE Committee on Instruments and Measurements. This subcommittee had five meetings during the year. Information being gathered will be published.

COMMITTEE ON FEEDBACK CONTROL SYSTEMS

The principal activities of the Committee on Feedback Control Systems aside from papers and technical sessions have been centered around the Subcommittees on Bibliography and on Terminology and Nomenclature. In addition, a Special Conference on Feedback Control Systems with exhibits and scheduled demonstrations as well as conference papers was held in Atlantic City, N. J., on April 21–24, 1954.

The Subcommittee on Bibliography under Professor D. M. Jones of Northwestern University has submitted, in three parts, a bibliography on feedback control systems covering literature from 1850 to 1952. These have been submitted for publication in *Transactions*. The Subcommittee on Terminology and Nomenclature under H. W. Cory has prepared and will soon submit to the Standards Committee for acceptance a tentative standard on this subject.

In all, the committee has held technical sessions at the Summer General, Fall General, and Winter General Meetings as well as the North Eastern District Meeting.

These amount to nine sessions of four papers each. There continue to be many papers for future sessions.

COMMITTEE ON GENERAL INDUSTRY APPLICATIONS

The Machine Tool, Rubber and Plastics, and Textile Subcommittees have been very active during 1953–54. Their various conferences have been reported and accounts have been printed in other reports.

The Materials Handling Subcommittee has been reactivated and a conference is planned for early next year. The personnel of this committee has been changed somewhat and is now composed of men all vitally interested in this industry.

A Pacific Coast Subcommittee has been formed. A most enthusiastic subcommittee has been selected and they will perform the function of the General Industry Applications Committee in the Pacific Coast region. This subcommittee has arranged a session at the Summer and Pacific General Meeting. It is expected that this subcommittee will fill a long-felt want in this region.

The Paper and Pulp Subcommittee is in the process of reorganization and expects to start the next year with a full working committee.

In order better to co-ordinate the functions of this committee, an Executive Subcommittee has been formed. The purpose of this committee is to co-ordinate the work of the various subcommittees and the main committee. By such action it is hoped that the work of this committee will be of greater benefit to the industry it serves.

The Textile Subcommittee has reached an agreement with the NEMA control group regarding standard control enclosures for this and other industries. It is also working on suggested codes and regulations for all electric equipment used in the textile industry.

COMMITTEE ON INDUSTRIAL CONTROL

Three technical sessions were held at the Winter General Meeting in January; two sponsored jointly by the Committee on Mining and Metal Industry and the Committee on Industrial Control, and one independent meeting on electronic control. The meeting on electronic control was well attended with considerable discussion and questions from the floor. This meeting was set up primarily to stimulate interest of both manufacturers and users in the need for definitions and performance standards for industrial regulating controls. From the audience participation at this session, it could be assumed that the need was recognized; however, the proof as to whether or not any real good was accomplished, will come as a measure of subcommittee activity during the coming year.

Subcommittee on Standards. The work of this subcommittee upon revising control symbols was finalized by the issuing of recommended revisions in November 1953 and will appear as a revision of *Z32.1*. This subcommittee has additional items on its agenda and will continue during the coming year.

Subcommittee on Test Codes. This subcommittee has been struggling to obtain final approval on test methods but it is expected that this work will be completed early in the coming year.

Subcommittee on Electronic Control. There is considerable work to be done by this subcommittee on nomenclature, definitions, and standards; and there seems to be general realization that the work needs to be done. However, there has been a definite problem in getting the members of this subcommittee to spend the necessary time required to straighten out and organize the problems which confront this growing control field. A sincere effort will be made during the coming year to step up the work and thereby improve the progress of this subcommittee.

Subcommittee on Regulators and Feedback Control Systems. This subcommittee is functioning as a liaison group working very closely with the Committee on Feedback Control Systems. This joint effort has progressed very satisfactorily and a report entitled "Terminology for Feedback Control Systems" has been issued. As a result of similar activity in the ASME, a sectional ASA committee has been formed to develope approved American standards covering definitions and symbols used in the regulator and feedback control field. This subcommittee should take an active interest in this ASA sectional committee.

COMMITTEE ON INDUSTRIAL POWER SYSTEMS

This committee will have held four technical sessions at the three General meetings this year, and the committee meeting was held during the Winter General Meeting.

The joint sessions work of this committee with the Committee on Insulated Conductors at the 1953 Fall General Meeting was concluded by the issue of Special Publication *S-56*, "Symposium on the Use of Aluminum for Insulated Conductors."

This committee is assigning the responsibility of organizing technical sessions to its members for the purpose of personnel development and spreading activity among its members. Committee members have accepted responsibility of technical session sponsorship for General meetings to and including the 1955 Fall General Meeting.

The activity of this committee's Pacific Coast membership is being enlisted by the organizing of the proposed Pacific Coast Subcommittee having the following scope:

This subcommittee shall comprise the Industrial Power Systems Committee membership in the AIEE geographical Districts 8 and 9 organized for the purpose of considering as a group those committee problems of particular interest on the Pacific Coast, presentation of such problems at executive and committee meetings of the Industrial Power Systems Committee, and for organization of committee activities on the Pacific Coast.

Subcommittee on Industrial Grounding produced basic material on industrial power system grounding which was presented at a technical session at the Winter General Meeting for discussion and comments. This material is now being revised for the purpose of recommendation to issue as a special publication.

Subcommittee on Electric Power Distribution for Industrial Plants made good progress on the assembly of the several chapters for the revision of the Red Book "Electric Power Distribution for Industrial Plants." This phase of the revision should be completed in 3 months.

Subcommittee on Distribution Systems for Commercial Buildings recognizes a substantial increase in the size and load of some commercial buildings and the use of 460 volts for distribution. This makes it desirable to revise the Green Book "Interior Wiring Design for Commercial Buildings." It is proposed during next year to establish working personnel groups to make this revision.

Subcommittee on Codes and Standards has been unable to take an active part in the formation of codes and standards this year. A modest approach to this activity is being taken in continuing the work of this subcommittee.

Subcommittee on Power Supply has been inactive this year and is being discontinued as a subcommittee.

COMMITTEE ON MINING AND METAL INDUSTRY

The Committee on Mining and Metal Industry was organized in 1947 and consists of three Subcommittees on Metal Industry, Western Mining, and Eastern Mining.

One of the prime objectives of this committee is to generate interest in the AIEE in the mining and metal industries. A secondary objective is to bring news to AIEE members of technical developments and achievements in the mining and metal industries through the means of conference and technical papers presented at Institute meetings. The committee has attempted to keep close liaison between the AIEE and such organizations as the American Mining Congress and the Association of Iron and Steel Engineers. There is much interest in the committee as evidenced by the rather large membership on the main committee and the subcommittees, and by attendance at meetings sponsored by the committee. It is felt that the committee is progressing satisfactorily towards its objectives.

Power Division

COMMITTEE ON CARRIER CURRENT

During the past year, this committee sponsored technical sessions at the Winter and Summer General Meetings. In addition, an informal symposium on carrier and microwave was held at the Pacific General Meeting. This symposium was well attended, and many problems of general interest were discussed. In view of the success of this meeting, a microwave symposium is being planned for some future General meeting in the East.

Several of the subcommittees have completed their investigations during the past year and committee reports have been presented as formal papers. Rather than create new subcommittees at the present time, it was decided to utilize the available personnel to concentrate on the work ahead of the remaining active subcommittees.

A summary of subcommittee activity follows.

Executive Subcommittee. This subcommittee has the continuing function of assisting the chairman, and has aided in formulating a revised scope of the Methods of Measurements and Microwave Subcommittees.

General Interest Paper Subcommittee. A paper on carrier and microwave prepared by this group was presented at the American

Power Conference in Chicago, Ill., in March 1954.

Methods of Measurements Subcommittee. This subcommittee is performing the important function of setting up recommended methods of obtaining carrier frequency characteristics of power and carrier apparatus. Uniformity in the measuring procedure is necessary if results obtained from different sources are to be tabulated and compared.

To expedite the work of this subcommittee, it has been divided into four working groups under one co-ordinating chairman. These groups are (*a*). measurements of line characteristics at carrier frequencies; (*b*). measurement of the characteristics of carrier equipment; (*c*). measurement of the characteristics of power equipment at carrier frequencies; and (*d*). measurement of noise characteristics at carrier frequencies.

It is expected that investigations under these four subjects will ultimately result in a field test manual.

Microwave Subcommittee. The work of this subcommittee has been clarified by revising its scope to include the following three main headings: 1. operating and economic requirements; 2. equipment; 3. propagation.

Carrier Bibliography Subcommittee. This is a continuing activity to obtain a complete record of the literature on carrier and microwave.

Standards for Carrier Radiation Subcommittee. The field of activity of this group has been defined to include the following subjects: 1. methods of measurement of radiation of carrier energy from power lines; 2. methods of measurement of carrier equipment characteristics which affect radiation; 3. Proposed limits for carrier equipment to minimize radiation and possible interference.

Activity will shortly begin on obtaining information under these three headings.

COMMITTEE ON INSULATED CONDUCTORS

During the year the Committee on Insulated Conductors sponsored five technical sessions at the Summer, Fall, and Winter General Meetings. The committee reviewed a number of papers and 21 were scheduled for meetings held during the year. In addition, seven papers will be on the program of the 1954 Summer and Pacific General Meeting. The sponsorship of the sessions at the General meetings resulted from the basic work of the committee which was carried on at two 2-day meetings held in New York, N. Y., in November 1953 and in St. Louis, Mo., in April 1954. In both cases individual meetings of the various subcommittees were held on the first day, followed by a general meeting of the entire committee on the second day. In addition to the 12 subcommittees (i.e., Administration, Standards and Publications, Cable Characteristics, Conductors, Insulations, Sheaths and Coverings, Cable Supply Systems, Utilization Wiring Systems, Special-Purpose Cable, Accessories, Structures, Tests and Measurements) under which the activities of this committee have been carried on in the past, a new subcommittee, Number *13* European Practice, has been set up to cover new, novel, or unusual European development, practice, or experience on matters coming within the scope of the committee and to promote the participation and co-operation of European engineers in the activities of the committee. The personnel of the new subcommittee includes representation from such countries as Denmark, France, Germany, Great Britain, Italy, Holland, Sweden, and Switzerland.

An AIEE Special Publication (*S-56* "Symposium on the Use of Aluminum for Insulated Conductors") containing ten conference papers on insulated aluminum conductors became available in October 1953. Most of the papers included in this publication were presented at the 1952 Fall General Meeting under the joint sponsorship of the Committees on Insulated Conductors and Industrial Power Systems.

Many important projects were given consideration by the various subcommittees during the year. A few typical subjects under consideration or investigation are the following:

Standards and Publications Subcommittee. Tabulation and classification work on the "Classified Bibliography of Insulated Conductors," a bibliography of the important technical articles on insulated conductors published in English in the technical press over the past 20 years or so, is nearing completion and tentative plans are being studied for its publication and for issuance of yearly supplements to keep the publication up to date.

Cable Characteristics Subcommittee. Studies continue on a number of important projects, such as the observed instability of the thermal resistivity of the soil in some locations under certain conditions which appear to be related to the soil type and to moisture migration characteristics, the effect of weekly load factor on the load capability of buried and pipe-type cables, the hydraulic aspects (i.e. oil flow, pressure drop, etc.) of oil-filled pipe-type cable systems, and calculation and evaluation of the sheath losses in multiconductor aluminum-sheathed power cable.

Cable Supply Systems Subcommittee. Developments in high-voltage cable systems are followed closely and during the year six papers were presented covering recent novel installations of high-voltage cable in the United States, Canada, and Sweden. Plans are being made, in collaboration with a working group of the Accessories Subcommittee, for the presentation in the near future of a group of papers covering the fundamental requirements for the application of nonleaded cable to secondary distribution systems.

Structures Subcommittee. Several papers were sponsored during the year on engineering practices as distinguished from papers on new developments in the art. Into this category fall two papers on submarine, bridge, and viaduct crossings which were presented at the Fall General Meeting, and another paper now in preparation on cable tunnel crossings.

COMMITTEE ON POWER GENERATION

Three committee meetings were held during the year, one at each of the Institute General meetings. Increased interest has been shown in this rapidly developing field and as recognition of this, the membership has been enlarged in recent years. Technical sessions were sponsored at all of the General meetings, some of which were joint sessions with other committees. Reports of the activities of all subcommittees have been submitted, and are summarized as follows:

Prime Movers Subcommittee. A technical session was held to review for the membership the progress in steam generation, steam turbines, gas turbines, and diesel engines.

Speed Governing Subcommittee. This subcommittee co-operated with the Committee on System Engineering's Control Subcommittee in sponsoring further technical sessions on load control and frequency regulation. One session was devoted to reviewing the modern controls and protective features in general use for steam turbine-generator sets. A composite report, in co-operation with the Station Design Subcommittee, is planned to summarize control and protective features of the over-all steam-electric station.

Excitation Systems Subcommittee. This committee has continued its work on developing a group of definitions for excitation systems, working toward the general objective of definitions for exciters, regulators, and excitation systems. Progress is being made in this regard but no report is yet available.

Station Design Subcommittee. Interest in the protection of boilers and associated auxiliary equipment continues to grow as higher pressures and larger units are built. Consequently, the Station Design Subcommittee is continuing its studies of boiler protection, hoping that useful recommendations can be developed. The subcommittee has also undertaken a review of the standards for fire protection of power plants with the objective of obtaining broader recognition in the industry of the latest improvements in fire protective equipment for power plants. For this purpose, a working group has been established.

Application of Probability Methods Subcommittee. A preliminary report on the outage data of high-pressure turbines and boilers for the years 1950–51–52 was submitted at the January 1954 subcommittee meeting. This report is now being circulated among the members of the subcommittee and of the sponsoring committees. The report will be presented at the Fall General Meeting in Chicago next October.

Two reports, summarizing and co-ordinating previous work on the determination of system reserve capacity by the probability method, were prepared respectively by two members of the subcommittee. The first was circulated among the members of the subcommittee. The second was circulated among the members of the subcommittee and of the sponsoring committees.

The subcommittee is still interested in the preparation of a manual but during the year no progress was made, other than the two reports which, it is hoped, will form the initial nucleus of the manual.

Recommended Specifications for Prime Speed Governing. The draft of a specification for the speed governing of internal combustion engine-generator units is now out for review by the main ASME-AIEE Joint Committee members. There remains to be determined appropriate numbers to be included after which the complete specification will be issued for trial use. The joint committee has been co-operating with the ASME Power Test Code Committee Number *20* in the preparation of a code for testing of speed-

governing systems of steam turbines. Finally the numbers in the specifications for steam-turbine governing systems need review now that the industry has adopted maximum ratings for steam turbines.

COMMITTEE ON PROTECTIVE DEVICES

The Committee on Protective Devices sponsored a technical session at the 1953 Summer General Meeting, and had a joint session with the Transformer Committee at the Fall General Meeting and two joint sessions with the Transmission and Distribution Committee at the 1954 Winter General Meeting. Committee meetings were held in June 1953 and January 1954, both of which were during General meetings of the Institute.

The past year has been one of evolution, change, and evaluation rather than one of decision as far as the work of the Committee on Protective Devices is concerned. Changes have been announced by all manufacturers lowering the protective levels of line- and station-type lightning arresters, thereby affecting the work of the Lightning Protective Devices Subcommittee. Not only have arrester characteristics been changed, but new trade names and classifications of arresters have been introduced which have contributed to the lack of agreement among committee members and others. The problems created are being studied carefully by the various working groups, and progress has been made, although considerable work is yet to be done.

The results of previous work by the Fault Limiting Devices Subcommittee covering three guides—1. Guide for Application of Ground Fault Neutralizers; 2. Application Guide for the Grounding of Synchronous Generator Systems; 3. Application Guide on Methods of Neutral Grounding of Transmission Systems—are being considered by the Standards Committee for approval in order to make the material available in separate pamphlet form in addition to the present publication in AIEE *Transactions*. These guides are affected to some degree by lack of agreement on definitions of grounding terms as well as a difference of opinion as to what a guide should contain. Part of the work of this subcommittee is directed toward clearing up these differences.

The following is a brief report of each of the three subcommittees:

Fault Limiting Devices Subcommittee. A working group was organized to review the proposed revision of AIEE Number *32*, Standard for Neutral Grounding Devices. This work will include a review of definitions of grounding terms as established by practice and as included in the newly revised definitions in ASA *C42*.

In co-operation with the Subcommittee on Industrial Grounding, the second draft of a guide for grounding of electric power distribution systems in industrial plants is now being reviewed.

The working group for reviewing the factors affecting the use of protective devices in shunt with reactors has carried on the following projects and is preparing a report.

1. A study of reported troubles on both industrial and utility applications of reactors. The cases included in the study were obtained as a result of a questionnaire submitted to 45 users.
2. Computer studies to determine what overvoltages could be produced on circuits containing lumped reactances.
3. A special study on one particular system involving 13.8-kv cable circuits with reactors where overvoltages had caused considerable trouble.
4. A study of forced current zero and simulated cable faults on circuits with reactors.
5. Studies of the mechanisms producing overvoltages in reactor-protected cable feeders when the supply circuit breaker was operated.
6. A study of overvoltage problems with neutral grounding reactors.

A working group to study various means for reducing ground resistance of transmission systems has been organized and a program for action has been prepared.

Lightning Protective Devices Subcommittee. The American Standards Association Lightning Arrester Standard *C62.1* (AIEE Number *28*) issued in 1944 under sponsorship of AIEE is under revision to include developments in the field of lightning protection. The first proposed revision, AIEE Number *28-A*, was issued in 1950. The second proposed revision, AIEE Number *28-B*, has been completed by the working group and is now being considered by the subcommittee. A trend toward lower discharge voltage characteristics and higher power follow current, as presented in a conference paper at the January 1954 Winter General Meeting, requires more consideration of the duty cycle test requirements. The classification of arresters, which held up agreement on the report, is believed to have been resolved by requiring all design tests to be reported in the manufacturer's literature, in particular where a choice of severity in test is permitted.

The Working Group on Lightning Protection of Aerial Cable has prepared a questionnaire for a survey of service experience and performance in this area of system operation.

The Working Group on Direct Stroke Protection of Substations is preparing an additional questionnaire for the collection of more data on service experience. A conference paper was presented in January 1953 on the experience data obtained from the first questionnaire.

The Lightning Arrester Application Guide is under reconsideration by the subcommittee. The lowered discharge voltage characteristics of valve arresters play a large part in the discussion of recommended protective practices with respect to the separation of arresters and transformers. Two technical papers are being reviewed which will help evaluate these lower arrester characteristics.

Insulation Co-ordination Subcommittee. This subcommittee functions in a liaison capacity between the Protective Devices Committee and AIEE Standards Co-ordinating Committee Number *8*. The latter committee is studying and preparing a report covering recommended standard values of basic impulse insulation levels up to 1,750 kv. In the course of the work of Committee Number *8*, many problems of co-ordination of insulation of the various types of apparatus are discussed. Progress is being made in the establishment of standard values of basic impulse insulation levels, and this work has been reported by AIEE Committee Number *8* and will be found in the *Transactions* record.

COMMITTEE ON RELAYS

This committee has held three meetings during the past year. The spring and fall meetings are 2-day sessions; the first day being devoted to project committee and subcommittee meetings, and the second day to the main committee meeting.

Three technical sessions were sponsored during the year, and plans for two joint sessions and additional relay sessions are in progress. One new project committee was formed having the following descriptive title, "Devices for Control of Load Shedding and System Separation." This group will study relaying devices for these purposes, and their work will be closely co-ordinated with the work of H. L. Harrington's group which is studying this problem from the system engineering standpoint. There may be a joint session on this subject.

Some of the highlights of the work of the various subcommittee and project groups are as follows:

Subcommittee on Revision of Standards on Power Relays. At the present time this subcommittee is attempting to define standard characteristics for induction relays, and is having difficulty co-ordinating the various ideas of relay engineers and manufacturers. This work will take considerable time and effort.

Subcommittee on Line Relay Protection. The name of this committee has been changed so that if any follow-up work is required after the Joint Project Committee on Co-ordination of Construction and Protection of Distribution Circuits has presented its report the relaying aspects of this work can be continued.

This subcommittee has selected seven papers which are being combined to provide a brochure on transmission-line protection.

Subcommittee on Generator Protection. This subcommittee will follow the application and operation of the newly developed negative sequence generator relays which have been rather completely covered in previous Relay Committee activities.

New developments and requirements for generator relay protection will also be covered.

Subcommittee on Electronic Relay Applications. A 4-paper session was presented at the Winter General Meeting, under the sponsorship of the Relay Committee. This subcommittee will continue to follow developments of electronic schemes as applied to relay protection.

Pacific Coast Subcommittee. This is a very active group which is again sponsoring a relay session with four papers for the Summer and Pacific General Meeting.

Co-ordination of Relay Protection of Industrial Power Systems With Utility Systems. This project committee has prepared a report covering material on the subject of relaying for a chapter in the revised edition of the "Red Book" (Electrical Power Distribution in Industrial Plants).

Effect of Vibration and Shock on Relays This project committee is now circulating a final report for comments, and the report

was brought up at the May meeting of the Relay Committee for approval.

Other groups working on new assignments include a group working on pilot wire, one on test methods, one on relaying performance of current transformers, and one on devices for control of load shedding and system separation.

COMMITTEE ON ROTATING MACHINERY

The major activity of this committee continues to be directed toward preparation and revision of standards relating to rotating machinery. A new Working Group on ASA Standards was established in the interest of promoting closer liaison between the committee and the standards activities of ASA. The membership of this working group is now made up of the AIEE representatives and alternates on ASA *C-50*. In the future, membership will be expanded by adding AIEE representatives of *C-42*, *C-6*, and other ASA committees in which this committee is interested.

Technical activities, in the form of papers and sessions, continue at a high level, particularly at the Winter General Meeting at which nine sessions and 42 papers were sponsored by the committee. A serious effort is being made to divert papers to the Fall General Meeting in the interest of reducing the congestion at future Winter General Meetings.

Synchronous Machinery Subcommittee. Two sessions were sponsored at the Winter General Meeting, and one each at the North Eastern District and Summer General Meetings are scheduled. The working group on preparation of a "Guide for the Operation and Maintenance of Turbine Generators" has been quite active and is making progress. However, this is a complicated project and much work remains to be done. The working group on revision of the "Test Code for Synchronous Machines," AIEE Number *503*, is making extensive revisions and estimates that a year will be required to get the code ready to present to the Standards Committee. A new working group was formed to establish liaison with ASA to keep the subcommittee informed regarding proposed revisions of ASA *C-50*.

Induction Machinery Subcommittee. High interest in this subject is reflected by the large number of sessions sponsored by the subcommittee, two at Fort Wayne, Ind., and three at the Winter General Meeting. Two sessions are being planned for the Fall General Meeting in Chicago. Meetings of the subcommittee were held in Fort Wayne and New York; the next meeting will be at Chicago.

Suggestions by the ASA have been incorporated in the revision of AIEE Number *500*, "Test Code for Polyphase Induction Machines," and it is now ready for resubmission.

D-C Machinery Subcommittee. Two sessions were sponsored at the Winter General Meeting. Two sessions are planned for the next Fall General Meeting.

The subcommittee has completed and approved a new table of temperature rises for d-c machines based on the data presented in a large number of technical papers in recent years. Since the Institute does not publish standards for d-c machines, this table is essentially a recommendation to other standardizing organizations such as ASA and NEMA. A working group has been appointed to revise AIEE Number *501*, "Test Code for D-C Machines."

Single-Phase and Fractional-Horsepower Machinery Subcommittee. A session was sponsored at the Winter General Meeting.

The revision of AIEE Number *502*, "Test Code for Single-Phase Motors," is almost completed, and it is hoped that the revised code will be approved and referred to the Standards Committee this year.

This subcommittee was joint sponsor with the Fort Wayne Section of a special technical conference on motor design and the application of motors to air-moving equipment in October. That this conference was very successful is indicated by the attendance of 355, a marked increase over the first motor application conference at Dayton, Ohio. Preliminary planning has been started on a third conference tentatively scheduled for the spring of 1955.

Electric Coupling Subcommittee. No generally accepted standard for describing the characteristics and for rating electric couplings, clutches, and brakes is in existence. This subcommittee is working on such a standard but due to the wide variety of equipment involved, it appears that it will be some time before definite progress can be reported.

Insulation Subcommittee. A session was sponsored at the Winter General Meeting and one is scheduled for the Summer and Pacific General Meeting.

This subcommittee is working actively on the preparation of test codes for classification of insulation systems as to class *A*, class *B*, etc., by tests simulating operating conditions rather than by an arbitrary and frequently inaccurate classification by chemical composition. The first fruit of this work, AIEE Standard Number *1C*, "Test Code for Evaluation of Systems of Insulating Materials for Random Wound Electric Machinery," has been issued for trial use as a proposed supplement to AIEE Number *1*, and a working group to review experience with this code has been appointed. A similar test code for form-wound coils is being prepared, and it is expected that there will eventually be codes for all commonly used winding constructions. A proposed "Insulation Maintenance Guide for Large A-C Machinery" will be ready for printing as soon as some editorial changes are completed, and will be issued for trial use in the near future. The subcommittee sponsored an experimental study of the "Effect of Overvoltages and Surges on Machine Insulation," the results of which for medium-size 2,300- to 4,150-volt coils were reported in a technical paper at the Winter General Meeting.

Test Code Subcommittee. This subcommittee co-ordinates the test code activities of the various subcommittees with the Standards Committee, ASA, and others. Since several of the subcommittees are actively engaged in test code revision, this subcommittee has been active during the year.

Publicity and Bibliography Subcommittee. Three "Committee Activity" reports were prepared for *Electrical Engineering* and a report of the committee's "Engineering Developments for 1953" was prepared for the January 1954 issue of *Electrical Engineering*. The "Bibliography on Rotating Electric Machinery" is being brought up-to-date, and it is expected that this work will be completed this year.

Carbon Brush Subcommittee (Joint with Committee on Air Transportation and NEMA). AIEE Number *504*, "Test Code for Carbon Brushes," prepared by this subcommittee, was published in October 1953.

Working Groups

1. *Per-Unit Definitions.* This group has reported but little progress due to encountering wide divergence in points of view, and these problems were discussed at the committee meeting on January 21. Suggestions were made which it is hoped will result in future progress.
2. *Letter Symbols for Induction Motor Quantities.* This group has prepared two proposed standards: "Standards for Induction Motor Letter Symbols" and "Dimensional Symbols for Induction Motors." Both have been balloted on favorably and will be submitted to the Standards Committee in the near future.
3. *ASA Standards.* This group has nothing to report, having just been established.

COMMITTEE ON SUBSTATIONS

For the past few years there has been some conflict among the Committees on Substations, Switchgear, and Electronic Power Converters brought about by the Working Group on Rectifier Switchgear which was a part of the Committee on Substations. To clarify this matter, the Distribution and Conversion Substations Subcommittee was broken down into the Distribution Substation Subcommittee and the Conversion Substation Subcommittee. The Working Group on Rectifier Switchgear was eliminated. The scopes of the various subcommittees were then revised in line with this new organization. The membership of the Conversion Substation Subcommittee includes representation of the coal and ore mining, electrochemical, industrial, and railway industries, the manufacturers of conversion equipment and members of the Committees on Substations and Electronic Power Converters.

The status of the various projects in working groups of the committee is as follows:

Automatic and Supervisory Control. Work is continuing on the questionnaire on supervisory control and telemetering which was sent out. The group is working with the Group Subcommittee on Telemetering on the revision of the 1948 Telemetering, Supervisory Control and Associated Circuits Reports.

Device Function Numbers. Work has started on revising ASA *C37.2-1945*," American Standard for Automatic Station Control, Supervisory and Telemetering Equipments."

Conversion Substations. Recommendations for grounding d-c switchgear housings and associated structures with a view to improving safety to personnel and equipment are being studied.

Substation Grounding Practice. This working group presented a technical paper at the Winter General Meeting and has completed its work for the time being. It is expected that a new working group to cover other phases of this matter will be appointed later.

Location and Design of Distribution Substations in Residential Areas. This working group has been studying this subject and it is expected that a report will be made to the committee within the next year. Whether this report receives any wider circulation will be determined at that time.

Recommended Minimum Clearances. This working group presented a technical paper at the Winter General Meeting and has completed its work for the time being.

Safety Consideration in Substation Design. This group presented a technical paper at the Winter General Meeting and has completed its work.

Extra-High-Voltage Substations. This group has prepared a bibliography of the available literature on substations with voltages above 287 kv. This bibliography has been furnished to the members of the Committees on Substations, Transmission and Distribution, and System Engineering.

Design and Utilization of Mobile Substations. This working group is presently gathering information on highway-type mobile substations in an effort to determine the most advantageous design of the mobile substation and of the substations to which it may be connected.

Circuit Breakers Versus Reclosing Fuses. This group presented a technical paper on reclosing fuses, automatic oil circuit reclosers, and automatic oil circuit breakers at the committee's technical session at the 1953 Summer General Meeting. This completed the work of this group.

The Committee on Substations sponsored a technical session at the 1954 Winter General Meeting and held meetings of the main committee and the various subcommittees and the working groups at that time.

COMMITTEE ON SWITCHGEAR

The committee held meetings on October 31, 1953, and May 21, 1954. Technical sessions were sponsored at the Fall, Winter, and Summer General Meetings during the administrative year.

The standards' work completed during the year is as follows: (*a*). Review and approval of Standard Number *27* for reference to ASA as an American Standard. (*b*). Revision of AIEE Standard Number *50* on "Automatic Circuit Reclosers" to include line sectionalizers. (*c*). The Standards on "Power Circuit Breakers," which had been submitted to ASA in the previous administrative year, have been approved and are available to the industry.

The detail work of the committee has been carried out in the several subcommittees and their working groups, as in previous years. The technical advancements in each of the committees are given in the following.

Administrative Subcommittee. This subcommittee has continued to function effectively as a co-ordinating group. It contains the chairmen of all the subcommittees as well as the officers of the Switchgear Committee and provides a medium through which the problems of each subcommittee chairman can be discussed and resolved. The subcommittee meets on the evening before each regular Switchgear Committee meeting. It has, therefore, been highly effective in guiding the committe chairman and in completing the program of the following day's meeting. Matters of main committee policy and subjects, which should be investigated by the various subcommittees, are discussed and decisions are reached regarding their presentation to the main committee.

Power Circuit Breaker Subcommittee. The work of studying a new method for rating power circuit breakers has been continued vigorously through the year, through the Working Group on Circuit Breaker Rating Methods. A paper, summarizing the conclusions of the working group, was presented at the January 1954 Winter General Meeting. The working group anticipates a formal report to the subcommittee at an early date. The new proposed rating is based upon the symmetrical component of the short-circuit current. The method is now under review in various other industry committees.

Other work now in process in the subcommittee, much of which is anticipated to be ready for consideration as new standard material when the proposed new rating method is ready for adoption in the preparation of a new standard, is listed as follows: 1. Single-phase-to-ground short-circuit interrupting ability of power circuit breakers. 2. Revision of "Electrical World Engineering Reference Sheet Number 52-29" printed in April 19, 1954, issue of *Electrical World*. 3. Preparation of standards for power circuit breaker performance on line charging current interruption. 4. Study of possible increase in the maximum design voltage ratings of power circuit breakers. 5. Study of changes in standard duty cycles of power circuit breakers to permit an increase in number of unit operations before inspection.

Low-Voltage Air Circuit Breaker Subcommittee. This subcommittee is actively engaged in the study of the following subjects, which are expected eventually to result in certain changes in Standard Number *20* and the preparation of a new AIEE standard: 1. Study of fault current calculation methods in d-c systems. This involves a careful study of the short-circuit characteristics of the many different types of equipment which may be used to supply power to a d-c system. 2. The preparation of a new AIEE Standard for Molded Case Air Circuit Breakers. 3. Study of requirements in generator field circuit breakers under a-c short-circuit conditions. This involves the transient overvoltages which appear across the field breaker when interrupting the circuit when the stator is short-circuited. It is expected this will result in some changes or additions to Standard Number *20*. 4. Study of requirements in low-voltage circuit breakers when switching capacitor loads.

Switches, Fuses, and Insulators Subcommittee. This subcommittee is engaged in several projects which are expected to result in revision of AIEE Standards Numbers *22* and *25*, with the possible addition of a complete new AIEE standard. The different items are 1. A set of definitions have now been prepared and approved on interrupter switches. This and other material concerning interrupter switches are expected to be made a part of Standard Number *22*. 2. A "Guide for Ice Testing of Disconnecting Switches" has been approved by the Switchgear Committee and a paper on the subject was presented at the Winter General Meeting in January 1954. 3. A working group has been organized to prepare a "Guide for the Operation and Maintenance of Fuses and Disconnecting Switches." 4. A working group has been organized to study and prepare a new standard on fuses for 600 volts and below. 5. A new working group has been appointed to review and revise the test sections of Standards Numbers *22* and *25*.

Automatic Circuit Reclosers and Sectionalizers. This subcommittee has been actively engaged since May 1953 in the preparation of a revised version of Standard Number *50* to include line sectionalizers. The new standard has been completed and should be in the hands of the Standards Committee by the time this report is in print.

The subcommittee is also investigating the various requirements of capacitor switches for distribution systems. This will be coordinated with some of the work being done in other subcommittees.

Switchgear Assemblies Subcommittee. This subcommittee has reviewed Standard Number *27* and finds no revisions are necessary. The standard has been recommended to the AIEE Standards Committee for submission to ASA as an American Standard. As such, other material will be added to it to make it more effective as an American Standard.

The subcommittee is near the completion of its work on a "Guide for the Application of Metalclad Switchgear in Outdoor Installations." A paper on this subject was presented at the Winter General Meeting in January 1954. Suggestions received have been reviewed and a revised draft of the guide is in preparation. It is expected that the guide may be issued as a supplement to Standard Number *27*.

COMMITTEE ON SYSTEM ENGINEERING

The committee sponsored a technical session at the Summer General Meeting; two technical sessions at the Fall General Meeting and at the Winter General Meeting it sponsored three technical sessions, two of which were held jointly with the Committee on Power Generation.

During the year, the committee held four meetings in which the reports of progress on the assignments of the subcommittees were reviewed and plans were made for the development of programs for technical sessions sponsored by the committee. Preparations were made for a technical session of five papers on the general theme of "System Reliability" to be presented at the North Eastern District Meeting in May 1954. Programs were also developed for technical sessions at the forthcoming Summer and Fall General Meetings.

System Controls Subcommittee continues its study of new developments and applications of automatic controls for the regulation of tie-line loads and frequency in interconnected power systems. This subcommittee maintains close contact with the work of the Committee on Power Generation in this field. Experience with recent installations of automatic control equipment is being studied in relation to fulfillment of requirements of individual systems. Clark Nichols was awarded first prize in the Power Division for his paper on "Techniques in Handling Load Regulating Problems on Interconnected

Power Systems." This paper was sponsored by the Committee on System Engineering.

System Economics Subcommittee sponsored several papers on the general subject of power losses on system interconnections and their effect upon economic loading of interconnected generating stations.

System Operations Subcommittee sponsored a program at the last Fall General Meeting with papers on subjects of significant importance in the field of electric power system operation, such as training methods for load dispatchers; ice-melting procedures for lines in operation; interconnected systems energy accounting procedure and operations in a large interconnected hydro system during a protracted drought. Study is being made on methods of operation during system emergencies involving temporary operation at reduced frequency and disconnection of load automatically or manually.

System Planning Subcommittee is studying the broader aspects of extra-high-voltage transmission. A program of papers is in preparation for the forthcoming Summer and Pacific General Meeting. Power system planning practices have been studied. Information has been contributed from more than 20 systems. Individual members of the subcommittee were assigned 11 subjects of apparent current interest for study and development.

Administrative Subcommittee met in March to formulate preliminary recommendations on the organization of the Committee on System Engineering and its subcommittees for the year 1954–55.

COMMITTEE ON TRANSFORMERS

The committee held three meetings during the past year. It sponsored technical sessions at the Summer, Fall, and Winter General Meetings.

The work of the committee is divided among five subcommittees; the following is a report of the activities of these subcommittees.

Subcommittee on Dielectric Tests. This subcommittee prepared a new table for standard dielectric tests for oil-immersed transformers to replace those parts of Table *11.030* of American Standard *C57.11* which cover oil-immersed power and distribution transformers. The form of the table was changed and the 825-kv basic insulation level was added. The revised table was approved by the Committee on Transformers and submitted to the Standards Committee. New tables are to be prepared also for the other sections of American Standard *C57* in line with the present plans of ASA to make each section of the standard complete in itself.

A "Test Code for Power Factor Testing" of the insulation of assembled transformers was completed by the subcommittee and is being reviewed by the main committee. It is expected that it will be submitted to the Standards Committee in the near future.

Other subjects under review and consideration are tests for transformers above 230 kv, the switching surge strength requirements of transformers, the need for two insulation levels for transformers rated 15 kv and below, and the adoption of simplified impulse tests for the commercial testing of transformers.

Subcommittee on Insulation Life. The value of 110 C for the measured hottest spot temperature rise for dry-type class *B* insulated transformers which was approved by the Committee on Transformers is now under consideration by ASA Sectional Committee *C57*. However, a counter proposal which was submitted to the ASA committee by NEMA is being reviewed by the AIEE Committee on Transformers. This new proposal divides dry-type transformers into three groups, each group having different temperature rises with insulating materials being chosen to meet the temperature to which they would be subjected based on their location in the transformer, and discards the present division of these transformers by insulation classes *A*, *B*, and *H*.

Tests of dry-type transformer insulation by the functional method using models are continuing in several laboratories. Experiments are being conducted to determine a satisfactory method to establish the useful life of the insulation for the accelerated tests.

A proposed revision of the short-circuit sections of American Standard *C57.12* are still under review by the Committee on Transformers and it is hoped that agreement will be reached soon so that they can be submitted to the Standards Committee.

Work has been started on a revision of the American Standard Guide for Loading Oil-Immersed Distribution and Power Transformers to include modern data on forced-oil-cooled transformers and to make other changes to bring the guide up to date and to make it more useful.

A Working Group on Insulation Requirements for Specialty Transformers has been formed to determine the approximate relations between insulating materials, temperature rise, and life expectancy of dry-type transformers in the specialty group.

Subcommittee on Insulating Fluids. A meeting of this subcommittee was held in January at which different phases of the work were assigned. The object is to prepare a guide on reclaiming oil. The phases of the work under consideration are 1. tests to evaluate condition of oil; 2. methods of reclaiming oil; 3. addition of inhibitors and precautions to be observed; 4. economic factors; 5. oil circuit breaker considerations.

The last item is included because the Committee on Transformers is handling the general subject of oil for the Power Division. Liaison is maintained with the Committee on Switchgear and the Committee on Instruments and Measurements through representatives on the subcommittee from each of those two committees.

Subcommittee on Magnetic Behavior. The only active project which this subcommittee has at the present time is one dealing with transformer noise. This is a very important problem but one for which it will take time to reach definite conclusions. A "Report on Transformer Noise Measurement Methods" prepared by a subgroup was presented at the 1954 Winter General Meeting in New York. Additional subgroups are to be formed to investigate other phases of this rather involved problem.

Subcommittee on Performance Characteristics. A revision of the American Standards for Reactors, *C57.16*, was approved by the Committee on Transformers and sent to the Standards Committee. It is now being considered by ASA Sectional Committee *C57*.

Work has been started on the preparation of a test code to define how tests on instrument transformers should be made and interpreted. Rearrangement of some of the material in the present test code and the standards is also under consideration.

The "Proposed Guide for Operation and Maintenance of Dry-Type Transformers with Class *B* Insulation" which was published, October 1952, for trial use is to be reviewed with the object of making it a completed guide.

COMMITTEE ON TRANSMISSION AND DISTRIBUTION

The committee held two meetings during the year. It sponsored sessions at the Summer, Fall, and Winter General Meetings. A steady flow of technical and conference papers shows an active interest in all phases of the committee work.

The major activities of the various subcommittees are outlined as follows:

Capacitor Subcommittee completed a supplement to its bibliography on capacitors carrying it through December 1952, and expects to issue additional supplements every 2 or 3 years as technical papers. Work is continuing on a revision of AIEE Standard *18* to bring it up to date and suggested changes are expected to be crystallized in the near future. A report is in progress on the problems of switching capacitors. Studies are continuing on short-time overvoltage characteristics of capacitors.

Distribution Subcommittee is continuing its studies of higher distribution voltages and also the problems of 480-volt secondary systems from the point of view of grounding practices and the need of standardizing on a higher secondary voltage in this class.

General Systems Subcommittee is collecting data on switching surges which should also be of interest to the Committees on Transformers and Protective Devices. Work is being done on assembling material on fault-locating methods on transmission lines. With the advances in high-speed reclosing switchgear arc de-ionizing times for faults on transmission lines are becoming more important and information is being collected on this subject.

Lightning and Insulator Subcommittee is continuing its study on impulse characteristics of insulators, wood and air in series, and rod gap flashover curves. A project has been started to establish the fundamental basis for determining the number of insulators on transmission lines, taking into account all the factors involved and material is being assembled. Other subjects are grounding practices in substations (in cooperation with the Committee on Substations), use of silicone on insulator surfaces in contaminated areas, and lightning experiences in the field.

Towers, Poles, and Conductors Subcommittee is continuing its series of papers on wood and steel for transmission lines and held a second session on this subject at the Winter General Meeting. This development has resulted in many valuable conference papers and efforts will be made to have some of these submitted as *Transactions* papers so as to be in the permanent record. A study is being made on fundamental design assumptions in regard to broken conductors since these vary widely throughout the country.

Further work is also to be done on conductor vibration. A project has also been established on life and treatment of wood poles.

General. Members of the committee are active in ASA Standards Committee *C-2* which is planning a revision of the National Electric Safety Code. The committee has worked closely with Committees of System Engineering, Protective Devices, and Substations in sponsoring papers and projects that are of mutual interest.

Science and Electronics Division

COMMITTEE ON BASIC SCIENCES

There is a wide range of interests in the field of this committee, the principal interests being sponsored by the various subcommittees, most of which have held one or more conferences during the year. Also, several sessions at various meetings were devoted to papers not coming directly under subcommittee sponsorship.

Subcommittee on Applied Mathematics conducted a conference on noise during the Winter General Meeting last January. This conference was very well attended and the discussion following the presentation of conference papers was lively.

Possibly the most important activity of the subcommittee was its taking part in the Conference on Applied Mathematics, held last October in New York, under the sponsorship of the National Research Council. The chairman of the subcommittee was delegated to this Council as AIEE representative. This conference was a step forward in promoting closer relations between engineers and mathematicians. The majority of those taking part in the conference were mathematicians; these came with the conviction that applied mathematics had a special role to play in modern technical developments and they were anxious to co-operate with engineers and physicists.

Subcommittee on Dielectrics has continued its major function during the year in sponsoring technical sessions dealing with the various aspects of the field of dielectrics. Major emphasis, however, has been directed toward developing information on the thermal evaluation of insulating materials. During the 1954 Winter General Meeting three sessions of papers were sponsored on this subject. Since considerable interest has been expressed in these papers, the decision was reached by the Publication Committee to reprint them in pamphlet form. These should be available some time after June 1.

Since a great need has been expressed for test methods for evaluating the thermal stability of insulating materials, a working group has been established whose function is to develop test codes for the evaluation of various types of insulating materials. Three task forces have already been appointed under this working group and a tentative draft for a test code for evaluating enamelled wire has already been completed. Work is under way on test codes for flexible sheet materials and rigid laminates. This work is particularly important since it will form the basis for revising not only AIEE Standard Number *1* which covers the insulation temperature standards, but also the IEC temperature standards now given in IEC publication Number *34*.

Subcommittee on Basic Concepts is continuing its work on current and voltage notation. They have also carried on discussions looking toward informing the AIEE membership on the questions of units to be brought up at the meeting of the IEC to be held in Philadelphia in September.

Subcommittee on Electric Circuit Theory sponsored two sessions during the year, one at the Winter General Meeting and the other at the Summer General Meeting. These were made up partly of solicited conference papers dealing with current problems in network synthesis. The scope of the committee had been expanded to include circuit theory related to nonlinear devices, particularly magnetic amplifiers and transistors, and the committee membership was increased by the addition of persons who are active in these fields.

Subcommittee on Magnetics. The continued interest in the theory and application of magnetic ferrites was the basis for one symposium held at the Winter General Meeting. The word "ferrimagnetism" is now generally used for the kind of ferromagnetism observed in these materials. Applications are to communication circuits and to high-speed pulses.

A second session was devoted to recent advances in domain phenomena, magnetostriction, and permanent magnets. There was a high level of interest in both sessions.

Subcommittee on Semiconductors and Transistors. The subcommittee held several sessions at the Winter General Meeting, devoted to reviews of new types of transistors and search for new higher-temperature materials. Close co-operation has been maintained with the Semiconductor Devices Subcommittee of the Electronics Committee. A review session on the present status of transistors was held, covering developments in fields of materials, devices, technology, and application. Two sessions devoted to a Conference on Selenium and Tellurium were also held, covering a review of recent studies on these materials. A session is planned for the Summer and Pacific General Meeting.

COMMITTEE ON COMPUTING DEVICES

As a result of the widespread interest, much of the committee's effort has been exercised through its participation in the Joint Computers Conferences. Reorganization of the Joint Computer Conference Committee to allow greater facility in the operation of the eastern and western activities required a major activity of the committee. The result is a modified organization of this committee with the following essential features.

1. The committee will have two members from each sponsoring society from the East Coast and two members from each sponsoring society from the West Coast. Three East Coast and three West Coast members will be appointed each year so that there will always be a one year overlap for continuity.
2. There will be two sets of officers, a chairman, secretary, and finance chairman for east and west.
3. The chairmen will appoint necessary program, local arrangements, publication, etc., committees to handle each conference sponsored by their respective committees.
4. A joint secretary-treasurer is unanimously appointed by the chairmen of the computing devices groups of the three sponsoring societies. He acts as co-ordinator both on policy and financial arrangements and all funds to and from the societies clear through him.

This arrangement has now been approved by both East and West Coast groups and provides an excellent working arrangement with flexibility and provisions which eliminate most of the difficulties of arranging the earlier conferences.

The next East Coast conference has been planned at the Bellevue-Stratford Hotel in Philadelphia, Pa., December 8–10, 1954, with the subject "Design and Application of Small Digital Computers." In the committee's consideration these are in the $50,000 to $200,000 class and are fully automatic computers. The program will make the scope clear.

At the December 1953 Joint Computer Conference and Exhibit in Washington, there were 1,075 paid and 111 complimentary registrations. There were 47 exhibit booths and the total receipts were $13,374. After estimated obligations, this leaves a balance of about $4,500. Thus, added to a fairly nominal registration fee which includes the cost of the proceedings, and this income from exhibits, these conferences are financially successful. They provide a much needed forum for concentrated discussion of particular phases of computer activity and have the tremendous advantage of concerted action on the part of AIEE, IRE, and ACM rather than dispersing this activity in several places.

The AIEE Computing Devices Committee operates through six subcommittees.

The Subcommittees on Digital and Analogue Computers and Analogue-Digital Converters have been primarily engaged in arranging programs of technical and conference papers. A West Coast Subcommittee is co-ordinating this job for the 1954 Summer and Pacific General Meeting.

The Bibliography Committee has substantially completed an extensive bibliography of computer literature to be published shortly as a technical paper.

The Subcommittee on Digital Computer Comparisons is considering the problem of comparing the problem-solving ability of different kinds of digital computers with the requirements imposed by the various broad classes of problems. In doing so, it is necessary to recognize that an ingenious programmer can trade between storage capacity and computing speed in solving a problem. This ability is one of the factors limiting the degree to which problems and computers can be compared. A technical paper is planned defining the significant measures of computer usefulness and of problem difficulty and indicating how these measures may be applied to a specific situation. This paper should be useful to users contemplating the building or purchase of a computer.

COMMITTEE ON ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

The work of this committee has been of an active and interesting nature. Immediately following the war when security regulations were relaxed and investigators again had time to review their work, there was a great variety of new material available. Interest was widespread because of the novelty of the field. As a result the activities of the committee were largely subjective in charac-

ter. As time passed the backlog of unpresented data and methods has decreased. Activities in some areas formerly covered only by this committee have now grown to the point where they represent an entire field of effort in themselves. In the case of one such field, scintillation counters, interest is now sufficient to warrant a technical conference on this one subject. The field of radiobiology has expanded to the extent that it has become one of the primary interests of a new society, the Radiation Research Society.

The concept of this committee, and of the division of which it is a part, is consistent with this changing pattern. As a result of this, the committee's work may be expected to change from a subjective to an objective attitude. This new attitude looks forward to longer range objectives and exploration of some of the newer and less well understood techniques.

During the past year the committee sponsored a session of four papers at the Pacific General Meeting in Vancouver, a session of five papers at the Fall General Meeting in Kansas City, and one of four papers at the Winter General Meeting in New York.

Plans for the next year include a Technical Conference on Electrical Techniques in Medicine and Biology to be held at the Morrison Hotel in Chicago on November 10 and 11, 1954. Field trips will be made to the Argonne Cancer Research Hospital and to the Radiobiology Laboratory of the Argonne National Laboratory. An evening meeting with a well-known speaker on a pertinent subject will be included in the program.

A joint session with the Committee on Nucleonics is scheduled for the Summer and Pacific General Meeting.

The committee feels that it is filling a real need as the sponsoring body for a discussion area to which the physician, the biologist, and engineer can come for a discussion of his work and problems. These groups have been generous with their praise of the Institute's support of this activity.

COMMITTEE ON ELECTRONIC POWER CONVERTERS

The technical activities of the committee are described in the action of the subcommittees and working groups. In addition, the committee sponsored one technical session at the 1954 Winter General Meeting. This session was well attended.

Standards for Hot-Cathode Power Converters. The draft of section II of "Standards for Hot Cathode Power Converters" has been revised and is now ready for approval.

Working Group on Protection of Electronic Converters. Since the report on protection of electronic converters which was issued in 1950, further progress in the treatment of circuits and calculation of fault currents has developed. A working group has been organized to prepare a report which will embody this progress.

IEC Standards. A joint working group of ASA Sectional Committee *C-34* and the Electronic Power Converter Committee prepared a report on minimum modifications of the 1953 IEC draft standards for guidance of the American delegate to the 1953 session of IEC Committee *22* at Opatija, Yugoslavia. A similar working group has been selected to examine the 1954 IEC draft standards, which are still not in conformity with the ASA point of view. A concerted attempt will be made to reach agreement with the other committee members at the 1954 IEC meeting in Philadelphia.

Revision of C-34 Standards. This project has been delayed pending development of the IEC standards.

COMMITTEE ON ELECTRONICS

The Committee on Electronics, largely through its subcommittees, has been very active in the past year in bringing before the Institute the advances and changes that are taking place in the electronics field. Such information is particularly timely in those fields where rapid advances are being made as in the ultrahigh-frequency generation and transmission of electromagnetic waves and in the semiconductor field.

Organization. The committee organization and that of its subcommittees has been relatively stable. A West Coast Subcommittee is being formed to promote closer liaison with the main committee and to bring before the Institute some of the very important work that is being done on the West Coast. A Liaison Subcommittee with IRE exists to promote closer co-operation between the two societies in electronic matters.

Special assignments during the year were as follows: 1. Committee activities reports for *Electrical Engineering*. 2. Annual report on technical advances in electronics for the January issue of *Electrical Engineering*. 3. Recommendations of suitable subject material in the electronics field for the proposed television program "Creative Frontiers." 4. Annual Best Paper Award. 5. Recommendations for consideration of the annual Edison Medal Award.

Conferences. The Electronics Committee continues to be active in sponsorship of conferences on selected technical subjects. These conferences are proving very important in bringing together individuals interested or working in particular fields and in promoting a better understanding of the problems and progress.

Electron Tube Research Conference. This conference was initiated by the IRE and is now held annually. AIEE participation is through the Electron Tube Subcommittee. For several years the conference has dealt primarily with the generation of ultrahigh frequency. This year's meeting will be held June 23–25 at Orono, Maine.

Semiconductor Devices Conference. Semiconductor devices were discussed initially in the Electron Tube Research Conference but as interest grew a separate conference has been organized. AIEE participation is through the Semiconductor Devices Subcommittee of the Electronics Committee.

Application of Semiconductor Devices. A joint conference with the IRE is being planned on the circuitry of semiconductor devices. The Electronics Committee is being represented by its Subcommittee on Electronic Circuits and Systems Engineering.

Electronic Components Symposium. The Electronics Committee is again acting as one of the sponsors for this conference which because of its very great interest has become an annual event. This year's conference is being held May 4–6 in Washington, D. C. N. Barry Carlton of the Department of Defense is chairman. It is expected that next year's meeting will be held on the West Coast.

National Electronics Conference. In accordance with custom, the Electronics Committee through its Electron Tube Subcommittee presented a technical session at this conference, Special emphasis was given to the progress and development in the microwave field. Papers were presented describing the physical concepts and theory of space-charge bunching in "backward-wave, traveling-wave oscillator" devices, voltage tuned microwave oscillators; air-borne r-f amplifier tubes, and high-power (10 kw) continuous-wave magnetrons mechanically tunable over a range of 785 to 845 mc.

Technical Sessions. Ten technical sessions were presented by the subcommittees of the Electronics Committee during the past year of which three were at the Summer General Meeting, one at the National Electronics Conference, and six at the Winter General Meeting.

Electron Tube Subcommittee. A very great amount of effort is being devoted to microwave tubes and the subcommittee has presented a carefully selected series of technical programs which have brought before the Institute the latest advances in this field. Papers on tube types such as the klystron, traveling-wave tubes, and backward-wave tubes were presented.

Semiconductor Devices Subcommittee. A symposium on standards was presented at the Summer General Meeting and a technical session at the Winter General Meeting. Both sessions provided an excellent opportunity for the members of the Institute to learn of the very rapid technical advances that are being made in this field.

Education in Electronics Subcommittee. In cooperation with the Education Committee of the Institute, a most interesting session was presented at the Winter General Meeting on the trends that are taking place in this field. More emphasis is being given to the basic factors involved and less to specific or special applications except for illustration. The 5-year undergraduate course at Ohio State University is being continued.

High-Frequency Conductors, Cables, and Connectors Subcommittee. The increased application of microwaves has required the development of new and comparatively strange forms of conductors. These, the problems of shielding, and the use of printed circuits were discussed at a technical session presented at the Winter Meeting.

Infrared Applications Subcommittee. Infrared detectors and techniques were discussed at a technical session at the Winter Meeting. Infrared transmission of information offers most interesting possibilities and additional sessions may well be presented as the material is released.

Standards.

Electronic Instruments Subcommittee. This committee, which initially was organized jointly by the Instruments and Measurements and the Electronics Committees, has presented standards on electronic voltmeters, signal sources, and cathode-ray instruments for consideration of the main committee and presentation to the Institute.

Semiconductor Devices Subcommittee. Standards on definitions of the terms describing semiconductor application, theory, and devices were presented to the Institute in a symposium as noted previously and have now been submitted to the AIEE Standards Committee. The work was carried out in co-operation with the corresponding IRE committee.

Electron Tube Subcommittee. Definition standards have been prepared on storage tubes and on industrial gas tubes. This work has been carried out in conjunction with the corresponding IRE committees and the proposed standards are being submitted for consideration.

COMMITTEE ON INSTRUMENTS AND MEASUREMENTS

Special technical conferences continue to hold precedence over the General meetings of the Institute for the presentation of technical papers sponsored by the committee. Because of the continued success of conferences with respect to the attendance and the caliber of the technical program, the following have informally established themselves as regularly recurring events:

The Scintillation Counter Symposium, the Conference on High-Frequency Measurements, and the Conference on Recording and Controlling Instruments are held biennially. The first two are jointly sponsored and the third is sponsored by the AIEE Subcommittee on Recording and Controlling Instruments. The Electronic Components Symposium, the National Telemetering Conference, and the Annual Instrument Conference and Exhibit are held annually. The Electronic Components Symposium alternates between Washington, D. C., in even-years and Los Angeles in odd-years. The Annual Instrument Conference and Exhibit is sponsored by the Instruments Society of America but the AIEE has sessions at this conference. In connection with the Scintillation Counter Symposium, the Committee on Instruments and Measurements serves jointly with the Nucleonics Committee and in connection with the Electronic Components Symposium the committee serves jointly with the Electronics Committee.

A comparison of the number of papers presented at special technical conferences and at General meetings shows that 93 papers were presented at the four conferences held during this Institute year, while 26 papers (15 technical and 11 conference) were presented at the committee's technical sessions at regular General meetings.

Standards. Revision of standard on recording and controlling instruments of the self-balancing type through ASA Committee *C39.2*: A draft incorporating preliminary revisions has been prepared for circulation to groups and manufacturers not represented on the committee. Detailed requirement sheets covering each major class of instruments covered by the standard have been planned.

Development of AIEE Standard number *4*, for measurement of voltage in dielectric tests, through ASA Committee *C68.1*: This standard was approved by the American Standards Association on September 11, 1953, and has been officially issued.

Master test code for power measurements: Subcommittee's final draft has been put up for Instruments and Measurements Committee vote. Balloting is almost complete and final committee redraft, incorporating final revisions, is in preparation for presentation to the Standards Committee. Collaborative study by interested ASME committees has been set up.

Proposed standard specification forms for electronic instruments (vacuum tube voltmeters, cathode-ray instruments, and signal generators): Final drafts from the cognizant subcommittee have been formally submitted to the Electronics and to the Instruments and Measurements Committees. Balloting is almost complete and final committee redraft incorporating revisions is being readied for presentation to the Standards Committee.

Master test code for rotary speed measurements: Cognizant subcommittee has completed an initial draft which has been informally referred for comment to the Test Code Subcommittee of the Rotating Machinery Committee. A canvass of manufacturers on current practice is in preparation.

Glossary of terminology and definitions for the field of telemetering: The cognizant subcommittee has virtually completed its glossary of terminology and definitions for the field of telemetering, with 192 terms having been processed for suitable form.

Committee Meetings. The committee held a meeting at the Summer General Meeting, June 17, 1953; a meeting at AIEE headquarters on October 7, 1953; and a luncheon meeting at the Winter General Meeting, January 18, 1954.

Committee Organization. The organization of the Instruments and Measurements Committee into its present structure involving group subcommittees was approved by the Committee on Technical Operations on January 20, 1954.

COMMITTEE ON MAGNETIC AMPLIFIERS

The Committee on Magnetic Amplifiers extended its coverage of the field of those interested in and working with magnetic amplifiers through the addition of a West Coast Subcommittee. This subcommittee operates with a great degree of independence in the handling of sessions and other matters directly relating to the West Coast.

Some reorganization of the other subcommittee organization of the main committee was also accomplished during the year. The Principal Groups Subcommittee was disbanded, and the Test Codes Subcommittee was merged with the Standards Subcommittee under the name of the latter. Most of the work of the committee is carried on by the subcommittees of which there are now six.

The committee sponsored technical sessions at the Summer and Winter General Meetings and contributed to other meetings. Two general business meetings of the main committee were held and numerous separate meetings of the subcommittees and their working groups also were held throughout the year. The submission of papers has been encouraged, and ample supplies for future meetings have been assured.

Applications Subcommittee continued its function of encouraging the submission of papers and the general exchange of information on applications of magnetic amplifiers. A program was organized for the 1953 National Electronics Conference by the subcommittee and was well received.

Definitions Subcommittee is concentrating on the standardization of definitions and symbols for use in the magnetic amplifier field. Changes and additions to a former progress report (AIEE *Transactions*, vol. 70, pt. I, 1951, pp. 445–9) are in process to bring it up-to-date. The state of the magnetic amplifier art and its rapid growth makes this work extremely difficult. Advances in the art continually change the requirements for definitions and terms to be applied to the circuits or used with the theories advanced.

Magnetic Amplifier Theory Subcommittee has continued to expand its operations. Several business meetings were held during the year. The magnetic core itself, as the heart of the magnetic amplifier, has become the center of attention of this group. Work of the past year has been directed toward the organization of a technical session to cover the basic magnetic theory associated with that element.

Materials Subcommittee has been very active in setting up standard testing methods for magnetic materials for use in magnetic amplifiers. A number of business meetings were held throughout the year, including an open meeting at the Winter General Meeting to which representatives of the core manufacturing industry were invited. During this meeting, numerous testing methods were described. The information gained at that meeting was to serve as a basis for further study by the subcommittee.

Standards Subcommittee has been limited to a great degree by the lack of definitions of certain terms. The former Test Codes Subcommittee was in somewhat the same position. Many points were of common interest to the two subcommittees, and, although still held up on definitions, the merger of the two subcommittees now enables the accomplishment of work which would otherwise have been delayed. The Definitions Subcommittee continues to be in close liaison with this subcommittee to ascertain its requirements.

COMMITTEE ON METALLIC RECTIFIERS

The activities of the Committee on Metallic Rectifiers are expanding due to the increased interest in semiconductor devices and their growth from small circuit components into power devices covering a wide range in voltages and are now entering into the 1,000-ampere sizes. Germanium and silicon have joined with selenium, copper oxide, and sulfide in the metallic rectifier field.

Organization. Five new subcommittees have been added to the existing six committees. New subcommittees covering semiconductor rectifying devices, germanium rectifiers, power rectifiers, and metallic rectifiers for magnetic amplifiers are being organized. In addition, a subcommittee was organized for publicity.

The Subcommittee on Technical Information is investigating problems peculiar to metallic rectifiers such as the effects of pulse loading, the effects of temperature, peak currents, and harmonics on ratings. The effects of chemical vapors, paint finishes, and oil immersion are being studied.

Data are being collected on the effect of current density on aging and the resulting life obtained together with record of failures in the field with contributing causes.

Standards. A preliminary test code for

metallic rectifiers stacks was distributed for comments. This when completed will supplement the definitions and test code on rectifier equipment.

Subcommittee on Patents. This subcommittee has issued a 100-page compilation of patents on metallic rectifiers, listed by subject and by assignment. This report is intended to be published through the AIEE.

The committee had added new members who will be included in the subcommittees. The liasion has been expanded to include three societies and five other committees.

COMMITTEE ON NUCLEONICS

Struggling always with the necessary security measures protecting most of the information on developments in atomic fission, the committee endeavored to secure papers for sessions under its own or joint sponsorship in order that AIEE members might be kept abreast of what can be revealed of the rapid progress being made. Attendance at sessions concerned with nucleonics at the Atlantic City Summer General Meeting was the highest ever. Co-operation of the committee helped provide nucleonics papers for the National Electronics Conference at Chicago in September and later in the autumn at the Conference on Electrical Techniques in Medicine and Biology. Recommending the policy that nucleonics sessions of AIEE meetings should be held where the largest numbers of interested members are likely to attend, the committee scheduled two sessions for the North Eastern District Meeting and two for the Summer and Pacific Meeting.

In order to keep its internal organization in shape to meet changes in the nucleonics field, the subcommittee structure was revised to the following: 1. Nuclear Machines, dealing with matters of electrical design, characteristics, or use; 2. Application of Nuclear Reactors to the Production of Power, planning for future atomic power development, including electrical means for control or safety; 3. Joint Subcommittee on Nucleonic and Radiation Instruments, contribution to measurements activities of the specialized knowledge of Nucleonics Committee; and 4. West Coast, a new subgroup thought to be justified for geographic reasons and the large interest in the field in that region.

The AIEE interest in possible changes in the Atomic Energy Act and co-operation with EJC panel on atomic energy received careful consideration during the year.

A growing problem continuously on the committee's agenda is the means of proper co-operation with nucleonics or atomic power interest groups in other sister societies such as ASME, ASCE, AIChE, ASTM, and IRE. Each of these and some others have a legitimate concern with some phase of nucleonics activity. The efforts of the committee are directed toward seeking the proper role of the AIEE in the whole picture, resisting the formation of any new specialized society in the nucleonics field, as it believes the present societies can meet the needs of the engineers of the nation if a proper co-ordination between existing groups can be realized.

AWARDS

EDISON MEDAL

The Edison Medal for 1953 was awarded to John F. Peters, consulting engineer, Special Products Development Division, Westinghouse Electric Corporation, "for his contributions to the fundamentals of transformer design, his invention of the Klydonograph, his contributions to military computers and for his sympathetic understanding the training of young engineers," and was presented to him on January 18, 1954, during the Winter General Meeting.

The medal may be awarded annually for meritorious achievement in electrical science, electrical engineering, or the electrical arts. Awards are made by a committee of 21 members of the Institute.

LAMME MEDAL

The Lamme Medal for 1953 was awarded to Frank A. Cowan, director of engineering, American Telephone and Telegraph Company, "for his outstanding contributions to long distance communication and the development of modulating and transmission measuring apparatus of original design and wide application." The medal will be presented to him on June 21, 1954, during the Summer and Pacific General Meeting.

The medal may be awarded annually by a committee of nine members to a member of the AIEE for "meritorious achievement in the development of electrical apparatus or machinery."

JOHN FRITZ MEDAL

The John Fritz Medal may be awarded annually for notable scientific or industrial achievements by a board of award composed of representatives of the American Society of Civil Engineers (ASCE), ASME, American Institute of Mining and Metallurgical Engineers (AIME), and AIEE. The 1954 medal was awarded to William Embry Wrather, director, U. S. Geological Survey, Washington, D. C., with a citation, "a geologist of worldwide experience and fame; an outstanding scientist and historian; a wise leader distinguished for his service to the nation."

The medal was presented to him on February 4, 1954, at a dinner in the Waldorf-Astoria Hotel, New York, N. Y.

HOOVER MEDAL

The Hoover Medal Fund was set up in order to provide a means of definitely recognizing outstanding civic or humanitarian services by a member of the engineering profession. The Hoover Medal Board of Award consists of 12 members, three each appointed by the four Founder Societies.

The Board decided not to make an award in 1953. So far this year the secretary of the Board has called for nominations of persons who are suitable candidates for the award. A meeting of the Award Board has been called for Thursday, May 4, in New York City. At this time the nominations which have been received will receive consideration, and the name of any candidate selected will be later submitted to the members of the Board for a letter-ballot action.

MARSTON MEDAL BOARD OF AWARD

This medal is presented annually at the commencement exercises of Iowa State College to a graduate of that institution who has achieved success in his field of engineering.

For the year 1953, the medal was awarded to Walter T. Wells, who has been associated with the production of aluminum ore in British New Guinea where he was in charge of the survey of about 1,000,000 acres of land carrying rich deposits of bauxite; and with the production of oil in Southern California where he developed an efficient method of restoring old wells to production by the use of explosives.

His work was thus in both mechanical and civil engineering fields.

WASHINGTON AWARD COMMISSION

This commission met several times during the year and the result of the final balloting was the nomination of Dr. Lillian Moller Gilbreth for the Washington Award. At a dinner held at the Furniture Club of America, Chicago, Ill., April 7, 1954, the Washington Award was presented to Dr. Gilbreth by Charles E. DeLeuw, president of the Western Society of Engineers (WSE). The attendance was estimated at well over 1,000 people. Robert H. Bacon, a member of the Award Commission, served as the chairman of the occasion taking the place of H. P. Sedwick, who was not able to be present at the ceremony.

Dr. Gilbreth delivered an address on "Management and Engineering." The general theme of her address had to do with the relation of management and engineering to human welfare.

The award is made annually to an outstanding engineer who must be a citizen or resident of the United States and who in his work has ably served human needs. The award is administered by a commission representing WSE, ASCE, AIME, ASME, and AIEE.

ALESSANDRO VOLTA MEMORIAL FUND

Maruizio Vallauri, of Turin, Italy, is the recipient of the third Volta Award under AIEE auspices. Mr. Vallauri is a graduate of the University of Turin and came here at the close of his tour of military service in the Italian Army.

Mr. Vallauri is studying ultrahigh frequency and electronics at the Massachusetts Institute of Technology as a candidate for the degree of master of science. He is continuing the record of the earlier recipients of the fellowship in the excellence of his work there.

As has become the custom, the Institute gave a luncheon for Mr. Vallauri during the Winter General Meeting attended by various officers of the Institute, trustees of the Volta Fellowship, and other interested members of the Institute.

Mr. Vallauri is a nephew of Professor Luigi Lombardi, who visited this country first to attend the International Electrical Congress in St. Louis in 1904 and who subsequently served as president of the IEC.

The first two recipients of the Volta Award under AIEE auspices are giving a distinguished account of themselves in Italy. Giovanni Malaman is in charge of system stability studies for the Edison System in Milan. Enrico Chiesa is employed by the General Electric Company of Milan in the development of electronic equipment.

H. S. Osborne, chairman of the Board of Trustees of the Volta Fund, last summer again visited Professor Barbagelata and other members of the Italian Electrotechnical Association in Milan, thanking them for their co-operation and discussing the future plans for the administration of the award.

COMMITTEE ON CHARLES LEGEYT FORTESCUE FELLOWSHIP

During the past year the Committee on Charles LeGeyt Fortescue Fellowships made several policy changes which it is believed will attract a better class of applicants for the fellowship. The stipend was raised from the $1,200 actually given and the $500 implied in the application to $2,000, and there was immediate evidence that the quality of this year's applicants was better than last year. Of the 26 applications received, the committee had a great deal of difficulty in resolving which was best out of the eight finalists, and although one was chosen and accepted, it is regretted that more fellowships are not available.

The committee also found that although the application form implied weight would be given to the formulation of a graduate plan by the applicant, this specification has yielded almost no useful data. Some good students offer no plan; others say that as seniors they feel some further exploration is necessary; while still others offer plans obviously laid down by their advisors. Therefore, it was agreed that in the future preference would be given to men just embarking on their graduate careers and little or no weight would be given to the development of a study or research plan. It is expected that these moves will still further strengthen the basis on which the fellowships are awarded.

The recipient of the award for the coming year is William L. Kilmer. Mr. Kilmer is a senior at the Pennsylvania State University and will do graduate work at the same institution this fall.

JOINT ACTIVITIES

UNITED ENGINEERING TRUSTEES

The United Engineering Trustees (UET) administers the funds and property of the four Founder Societies related to the Engineering Societies Building, The Engineering Societies Library, and the Engineering Foundation. It also serves as treasurer of ECPD.

During the past fiscal year, the major activity of UET has been the study of proposed locations, building sites, space requirements, types of structures, and methods of financing a new Engineering Societies Center Building. Several trips were made to proposed locations. Legal action to determine whether the proceeds of the sale of the present building can be removed from the city of New York was started.

The Founder Societies and the AIChE, which has declared its intention of joining in the proposed new building, have worked with UET by delegating committees of their Boards to study the building problem. At a meeting of 48 members of the Boards of the five societies in Chicago on April 6, 1954, there was recommended, and soon after authorized, a "Committee of Five Presidents" to expedite action in co-operation with UET.

ENGINEERING FOUNDATION

The Engineering Foundation is a department of UET devoted to the stimulation of research by activating grants which are generally supplemented by industry and others in a ratio of about $10 for each one dollar appropriated by Engineering Foundation.

For the year starting October 1953, Engineering Foundation provided grants totaling $43,000 in aid of 20 projects sponsored chiefly by the Founder Societies.

Requests on hand for the year 1954–55 indicate a growing demand for Engineering Foundation support for research projects.

ENGINEERING SOCIETIES LIBRARY

The Engineering Societies Library, a department of UET, is owned by, and operated chiefly for, the members of the Founder Societies who contribute about half the annual budget of $128,000. Operations of the library continue at about the same level of activity reported in some detail last year (*EE, Aug 53, p 750*). William G. Vieth, AIEE representative, was elected chairman of the Library Board at the beginning of the current administrative year in October 1953.

Efforts to acquaint the members of the Founder Societies and other engineers with the services available from the library have continued through displays at General meetings, mailings to the members, and notices in the publications.

Now, in its 40th year as a unified organization, The Engineering Societies Library faces the problem of adapting itself to the plans currently under discussion relative to a new Engineering Societies Center Building. The need for adequately housing the libraries of the four Founder Societies was an important element in the decision to unite in the present Engineering Societies Building 50 years ago. The question as to the place of the library in a new building is presently under discussion in the Board of UET. The 20,000 square feet needed adequately to house the library would probably cost upward of half a million dollars and represent an equivalent annual rental of about $80,000 to $100,000. The question as to whether, by the use of microfilm and other devices, it may be possible to make substantial savings in this space requirement is under study by the Library Board.

Pending the development of these plans, the Engineering Societies Library will continue to serve the members of AIEE throughout the nation, as well as locally, by mail, telephone, telegraph, and air parcel post.

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

The ECPD has continued at its usual high level of activity in the intraprofessional field. Its Education Committee is engaged in an attempt to raise the minimum standards of engineering education through strict adherence to its accredition routines. The Guidance Committee has prepared and distributed a great amount of material for the recruitment of superior high school students to the engineering profession. It feels that some small portion of the present increase in freshman engineering enrollments may be ascribed to its efforts. The Recognition Committee is continuing its work on uniform approaches to grades of membership, use of the professional degree, adoption of the Model Law, and in general, recognition of professional achievement. The current pilot project in professional development is in operation at Cincinnati, Ohio; the annual meeting of the council will be held in Cincinnati in October in order to accomplish, among other things, an on-the-spot review of the project. The Ethics Committee reports the adoption or endorsement of the canons of ethics by some 80 engineering organizations.

ENGINEERS JOINT COUNCIL

During the administrative year of 1953, EJC continued the administration of its intersociety duties in fields of interest to engineers, and also consolidated its expanded organization under a new constitution.

The four Founder Societies and the AIChE have had added to them the American Water Works Association, the Society of Naval Architects and Marine Engineers, and the ASEE as constituent societies.

The IRE and the National Society of Professional Engineers (NSPE) did not take advantage of their opportunity to join the council; there are other national societies, however, now in the process of preparing petitions for admission.

The organization of the council is still in the formative stage; under consideration at present is the adoption of constitutional amendments which will permit the admission of small national engineering societies as associate members and of regional groups as affiliate members. Also, the adoption of some form of individual membership is under consideration.

In the meantime, continued investigation of areas of co-operation with the NSPE and ECPD have been initiated. The already well established bodies on Engineering Labor Legislation, Water Policy, Atomic Energy, Employment Conditions, Engineering Manpower, and International Affairs are continuing their work assignments.

JOINT AIEE-IRE CO-ORDINATION COMMITTEE

The committee held one meeting during this fiscal year at which it was concluded that the major remaining subjects for co-ordination lay in the field of the Student Branches. It, therefore, recommended to the Board that it be discharged. By co-ordinated action of the Boards of the two societies, the committee was replaced by a special *ad hoc* committee of two representatives, with special experience and interest in Student Branches, from each society, to complete the work of co-ordination.

REPRESENTATIVES

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The AIEE representatives on the council of the American Association for the Advancement of Science (AAAS) report that although the AAAS went through a major change in executive personnel during the year just passed, no significant changes in policy or in operation occurred which affected the AIEE.

ATOMIC ENERGY COMMISSION ADVISORY COMMITTEE ON INDUSTRIAL INFORMATION

This committee has been constantly active in reporting to the Atomic Energy Commission information which would be considered valuable to industry if made available.

UNITED STATES NATIONAL COMMITTEE OF THE COMMISSION INTERNATIONALE DE L'ECLAIRAGE (CIE)

The U.S. National Committee of the CIE met at Swarthmore, Pa, on November 5 and 6, 1953. The principal item of business was

that of plans for the 1955 meeting in Zurich, Switzerland.

A preliminary survey indicates that a delegation of about 25 should attend this meeting. The chairman of the USNC Papers Committee reports good progress toward the objective of making available six United States papers, of which possibly two would be presented at a general papers session and four at technical committee sessions.

ENGINEERING SOCIETIES MONOGRAPHS COMMITTEE

During the past year, the work of the committee has been carried on by correspondence and telephone calls. Two manuscripts received by the committee were reviewed, but neither seemed suitable for Engineering Societies Monographs Series.

GENERAL ELECTRIC EDUCATIONAL FUND FELLOWSHIP COMMITTEE

The General Electric Educational Fund Fellowship Committee, which includes representatives of major scientific and engineering societies, met on March 24, 1954, and considered 191 applications for fellowship awards for the academic year 1954–55. Eleven awards were made. Four went to engineering graduates, including one to Frank S. Boxall who graduates in electrical engineering at Stanford University in 1954. Mr. Boxall will pursue graduate work at Stanford with a Charles A. Coffin Fellowship valued at $2,100.

NATIONAL BUREAU OF ENGINEERING REGISTRATION

There has been an increasing interest in the issuance of certificates of qualification by the National Bureau of Engineering Registration. These certificates do not authorize the practice of engineering in any state but the careful scrutiny of qualifications before issuance of such a certificate makes it of value to an engineer desiring to register in several states.

NATIONAL ELECTRONICS CONFERENCE

The ninth annual National Electronics Conference in September 1953 again showed an increase in attendance, that figure reaching nearly 6,900. At the same time the equipment exhibit of 150 booths at the Hotel Sherman in Chicago showed the latest in technical advances in the electronic and associated arts. Ninty-nine technical papers and three luncheon addresses were presented and the banquet was well attended.

The National Electronics Conference program continues to represent broadly both the industrial and communication aspects of the electronic industry. Breakdown of attendance figures shows a very broad representation from the fields of research, design, manufacturing, and education, and the programs are planned to interest a broad group.

The tenth conference will be held at the Hotel Sherman in Chicago on October 4–6, 1954, and will be featured as the tenth birthday of the conference with several special features planned. The AIEE representative served as president of the conference during 1953.

QUARTERLY OF APPLIED MATHEMATICS

Possibly the most important activity in this connection was the representation of the AIEE in the Conference on Applied Mathematics of the National Research Council which was held in October. This conference is believed to have resulted in a better understanding between engineers and mathematicians.

UNITED STATES NATIONAL COMMITTEE OF THE WORLD POWER CONFERENCE

During the past fiscal year, the Brazilian National Committee has completed arrangements to play host to the Sectional Meeting in Rio de Janeiro, July 25–August 10, 1954. The United States National Committee was allocated 11 papers, and several members are planning to attend.

The EJC assumed custody of United States National Committee funds during 1952, and on January 18, 1954, submitted a report on those funds to members of the National Committee.

The United States National Committee and its Executive Board met in New York, N.Y., in January 1954.

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

250 PARK AVENUE
NEW YORK 17

ACCOUNTANTS' CERTIFICATE

American Institute of Electrical Engineers:

We have examined the balance sheet of American Institute of Electrical Engineers, and schedule of securities owned, as of April 30, 1954, and the related statements of income and operating fund reserve and of restricted fund reserves for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet, schedule of securities owned, and statements of income and operating fund reserve and of restricted fund reserves present fairly the financial position of, and securities owned by, the Institute at April 30, 1954 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(*Signed*) HASKINS & SELLS

May 20, 1954

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit A — **Balance Sheet, April 30, 1954**

ASSETS			LIABILITIES		
Property Fund Assets:			**Property Fund Reserve:**		
Founder's interest (one-fourth) in capital assets of United Engineering Trustees, Inc.:			Founder's interest (one-fourth) in capital assets of United Engineering Trustees, Inc.:		
Land, buildings, and equipment (less funded depreciation and renewal reserve)	$269,261.29		Land, buildings, and equipment (less funded depreciation and renewal reserve)	$269,261.29	
Funded depreciation and renewal reserve	229,187.19		Funded depreciation and renewal reserve (marketable securities and cash held by United Engineering Trustees, Inc.)	229,187.19	
Total	$498,448.48		Total	$498,448.48	
Equipment:			Equipment, works of art, etc.	32,191.44	
Library (nominal value)	1.00				
Office furniture and fixtures (less reserve for depreciation, $45,910.54)	29,189.09				
Works of art, etc.	3,001.35				
Total property fund assets		$ 530,639.92	Total property fund reserve		$ 530,639.92
Restricted Fund Assets:					
Securities—at cost (quoted market value $944,102.28)—Schedule 1	$760,492.10		**Restricted Fund Reserves** (Exhibit C):		
Cash:			Reserve capital fund	$707,176.76	
Reserve capital fund	1,039.60		Life membership fund	6,178.27	
Life membership fund	1,135.57		Member-for-Life fund	19,015.13	
Member-for-Life fund	9,153.68		International Electrical Congress of St. Louis Library fund	6,623.59	
International Electrical Congress of St. Louis Library fund	1,580.89		Edison Medal fund	9,545.84	
Edison Medal fund	414.59		Lamme Medal fund	9,323.68	
Lamme Medal fund	391.24		Mailloux fund	1,033.14	
Mailloux fund	1,033.14		Volta Memorial fund	17,167.95	
Volta Memorial fund	580.14		Retired employees' insurance fund	4,000.00	
Retired employees' insurance fund	4,000.00				
Accrued interest—other than reserve capital fund	243.41				
Total restricted fund assets		780,064.36	Total restricted fund reserves		780,064.36
Operating Fund Assets:					
Cash	$ 11,272.16				
Accounts receivable:			**Operating Fund Reserve, Liabilities, Etc.:**		
Members—for dues (less reserve, $10,000.00)	14,064.58		Accounts payable	$ 61,304.89	
Advertisers	3,415.04		Deferred income, etc. received in advance:		
Technical Conference loans	2,350.00		Dues	9,856.41	
Miscellaneous	19,682.28		Entrance fees and dues of applicants for membership	508.80	
Accrued interest—reserve capital fund	2,511.77		Subscriptions to publications	28.652.00	
Inventories—at cost or less:			Miscellaneous (including unallocated receipts)	2,359.76	
Transactions	3,504.00		Operating fund reserve (Exhibit B)	12,082.01	
Text and cover paper	26,601.21				
Badges	7,261.93				
Production charges for May issue of *Electrical Engineering*	24,100.90				
Total operating fund assets		114,763.87	Total operating fund reserve, liabilities, etc.		114,763.87
Total		$1,425,468.15	**Total**		$1,425,468.15

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit B — **Statement of Income and Operating Fund Reserve for the Year Ended April 30, 1954**

Income:		
Dues (including $317,396.00 allocated to *Electrical Engineering* and bimonthlies subscriptions)	$551,670.01	
Advertising in *Electrical Engineering*	344,131.17	
Transactions subscriptions	23,660.78	
Electrical Engineering subscriptions	38,725.14	
Miscellaneous publications (preprints, Standards, bimonthlies, and other publications)	78,103.13	
Students' fees	26,343.75	
Entrance fees	21,844.00	
Registration fees—Institute meetings and technical conferences	31,994.06	
Membership badges	5,117.75	
Transfer fees	2,415.00	
Interest and dividends on investments of Reserve Capital Fund	33,078.97	
Miscellaneous	79.25	
Total income		$1,157,163.01
Expenses:		
Publications expense:		
Electrical Engineering		
Text	$233,252.12	
Advertising	166,833.05	
	$400,085.17	
Transactions	31,315.24	
"Year Book"	21,813.71	
Bimonthly publications	109,488.19	
Special and technical conference publications	59,429.02	
Institute meetings	43,245.70	
Institute Sections	104,742.95	
Institute Branches	11,584.34	
Section and Branch—paper prizes, including travel expense	5,372.02	
Finance Committee	1,100.00	
Headquarters Committee	1,908.10	
Membership Committee	24,472.55	
Forward	$814,556.99	$1,157,163.01
Total Income (forward)		$1,157,163.01
Expenses (forward)	$814,556.99	
Standards Committee	21,706.65	
Technical Committees	21,761.89	
Committee on Public Relations	18,085.30	
Constitution and Bylaws Committee	64.00	
Traveling expenses:		
Geographical Districts:		
Executive Committees	9,074.61	
Vice-Presidents	2,032.44	
Conferences on Student Activities	11,232.89	
Board of Directors	14,133.35	
Nominating Committee	1,800.05	
President's appropriation	3,654.34	
Institute representatives	154.30	
Administrative expenses:		
Salaries	117,039.05	
Stationary and miscellaneous printing	11,263.28	
Postage	8,716.55	
Social security taxes	3,118.09	
Legal services	250.00	
Rent, etc.—Editorial office, 500 Fifth Avenue	7,733.74	
Miscellaneous	10,581.19	
Retirement system—AIEE—normal contribution (including actuarial fees, $573.72)	12,249.54	
Geographical Districts—Branch paper prizes	811.32	
Institute prizes	628.77	
American Standards Association	1,500.00	
Canadian Radio Technical Planning Board	10.00	
Engineers' Council for Professional Development	2,770.00	
Engineering Foundation Project—Welding Research	250.00	
Engineers Joint Council	3,853.50	
National Council of State Boards of Engineering Examiners	500.00	
U. S. National Committee—International Commission on Illumination	300.00	
National Fire Protection Association	100.00	
United Engineering Trustees, Inc.:		
Building assessments	24,912.64	
Library assessments	18,602.70	
Library retirement plan	4,534.25	
Membership badges	6,319.29	
Exchange allowances to nonresident members	8,962.01	
Total expenses		1,163,262.73
Excess of Expenses Over Income for the Year		$ 6,099.72
Operating Fund Reserve, May 1, 1953		98,622.32
		$ 92,522.60
Less Transfers to:		
Reserve Capital Fund (Exhibit C)	$ 73,041.50	
Property Fund Reserve (for expenditures for furniture and fixtures, etc.)	7,399.09	
Total transfers		80,440.59
Operating Fund Reserve, April 30, 1954		$ 12,082.01

Exhibit C — **Statement of Restricted Fund Reserves for the Year Ended April 30, 1954**

	Total	Reserve Capital Fund	Life Membership Fund	Member-for-Life Fund	International Electrical Congress of St. Louis Library Fund	Edison Medal Fund	Lamme Medal Fund	Mailloux Fund	Volta Memorial Fund	Retired Employees' Insurance Fund
Balance, May 1, 1953	$688,008.30	$617,155.37	$6,528.14	$16,309.80	$6,618.74	$9,207.16	$9,258.22	$1,024.97	$17,905.90	$4,000.00
Additions:										
Contribution	70.00			70.00						
Transfer from operating fund (Exhibit B)	73,041.50	73,041.50								
Income from investments	1,937.09	*	137.50	262.50	137.50	675.00	345.00		379.59	
Interest on bank balances	70.29		38.12					32.17		
Dues paid by Members for Life	3,382.80			3,382.80						
Profit (loss) on sale of securities	16,923.64	16,979.89							(56.25)	
Total	$783,433.62	$707,176.76	$6,703.76	$20,025.10	$6,756.24	$9,882.16	$9,603.22	$1,057.14	$18,229.24	$4,000.00
Deductions:										
Authorized withdrawal from life membership fund	$ 525.49		$ 525.49							
Purchase of medals, cost of engraving, etc.	615.86					$ 336.32	$ 279.54			
Library purchases	156.65				$ 132.65			$ 24.00		
Traveling expenses—District Branch prize winners	1,009.97			$ 1,009.97						
Scholarship award	1,000.00								$ 1,000.00	
Cost of printing application and endorsement forms	61.29								61.29	
Total deductions	$ 3,369.26		$ 525.49	$ 1,009.97	$ 132.65	$ 336.32	$ 279.54	$ 24.00	$ 1,061.29	
Balance, April 30, 1954 (Exhibit A)	$780,064.36	$707,176.76	$6,178.27	$19,015.13	$6,623.59	$9,545.84	$9,323.68	$1,033.14	$17,167.95	$4,000.00

* Income on Reserve Capital Fund credited to Operating Fund.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Schedule 1 — **Restricted Funds—Securities Owned, April 30, 1954**

Name of Issuer and Title of Issue	Principal Amount	Book Value
Reserve Capital Fund:		
Railroad bonds:		
Baltimore & Ohio, Pittsburgh, Lake Erie & West Virginia System refunding 4%, due 1980	$10,000.00	$ 6,450.00
New York Central Railroad Company 4% series A consolidated mortgage, due 1998	15,000.00	9,812.50
Northern Pacific Railway Company 4½% collateral trust, due 1975	12,000.00	12,246.00
Total railroad bonds		$ 28,508.50
Public utility bonds:		
American Telephone & Telegraph Company 2¾% debentures, due 1975	$10,000.00	$ 10,062.50
Philadelphia Electric Company first refunding 2¾%, due 1967	10,000.00	10,325.00
Total public utility bonds		$ 20,387.50
Industrial bonds:		
Dow Chemical Company 3% convertible subordinated debentures, due 1982	$25,000.00	$ 24,656.25
Shell Union Oil Company 2½% debentures, due 1971	20,000.00	19,800.00
Standard Oil Company of Indiana 3¼% convertible debentures, due 1982	25,000.00	24,875.00
Standard Oil Company of New Jersey 2¾% debentures, due 1971	20,000.00	19,675.00
Total industrial bonds		$ 89,006.25
Dominion of Canada, externals 3%, due 1963	$10,000.00	$ 10,050.00
United States Government bonds:		
Defense bonds series G 2½%, due December 1, 1954	$13,000.00	$ 13,000.00
Treasury saving bonds:		
Series G 2½%, due September 1, 1955	40,000.00	40,000.00
Series G 2½%, due November 1, 1956	17,000.00	17,000.00
Series G 2½%, due May 1, 1957	20,000.00	20,000.00
Series G 2½%, due October 1, 1957	30,000.00	30,000.00
Series G 2½%, due May 1, 1961	30,000.00	30,000.00
Series G 2½%, due July 1, 1961	15,000.00	15,000.00
Total United States Government bonds		$165,000.00
Total bonds		$312,952.25

	Number of Shares	
Capital stocks:		
Preferred stocks:		
Atchison, Topeka & Santa Fe Railway Company	400	$ 19,174.71
General Motors Corporation $5	200	25,820.00
Ohio Edison Company 4.40%	200	21,279.25
Chas. Pfizer & Company, Inc. 4% cumulative convertible second preferred	100	10,245.20
Scoville Manufacturing Company 3.65% cumulative	100	10,111.25
United States Steel Corporation 7% cumulative	100	14,885.00
Total preferred stocks		$101,515.41
Forward		$414,467.66

Name of Issuer and Title of Issue	Number of Shares	Book Value
Total (Forward)		$414,467.66
Common stocks:		
American Gas & Electric Company	861	$ 15,069.04
Caterpillar Tractor Company	312	14,367.28
Christiana Securities Company	5	34,625.00
Consolidated Natural Gas Company	100	4,355.47
Eastman Kodak Company	381 19/100	9,699.90
General Electric Company	250	11,451.66
General Motors Corporation	200	4,235.53
Gulf Oil Corporation	324	9,176.09
Halliburton Oil Well Cementing Company	600	14,930.35
International Paper Company	330	14,479.88
Louisville & Nashville Railroad Company	100	6,278.13
Monsanto Chemical Company	100	9,635.60
Montgomery Ward Company	300	22,237.65
Owens-Illinois Glass Company	200	15,167.11
Pacific Gas and Electric Company	200	8,139.94
Public Service Company of Indiana	300	8,547.39
Public Service Electric and Gas Company $1.40 dividend preference common stock	500	14,462.43
Sears, Roebuck and Company	400	6,014.97
Socony-Vacuum Oil Company	400	8,146.18
Standard Oil Company of New Jersey	400	9,910.35
Standard Oil Company of Ohio	330	15,272.04
Texas Utilities Corporation	300	9,780.29
Union Carbide & Carbon Corporation	300	7,277.42
Westinghouse Electric Corporation	400	18,409.80
Total common stocks		$291,669.50
Total Reserve Capital Fund		$706,137.16

	Principal Amount or Number of Shares	
Life Membership Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1975	$ 5,000.00	$ 5,031.25
Member-for-Life Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1971	$ 5,000.00	$ 4,775.00
U. S. Defense bonds series G 2½%, due December 1, 1954	5,000.00	5,000.00
Total		$ 9,775.00
International Electrical Congress of St. Louis Library Fund:		
American Telephone & Telegraph Company 2¾% debentures, due 1975	$ 5,000.00	$ 5,031.25
Edison Medal Fund:		
General Electric Company common stock	150	$ 9,131.25
Lamme Medal Fund:		
E. I. du Pont de Nemours & Company $4.50 cumulative preferred stock	50	$ 5,952.00
General Motors Corporation $5 preferred stock	24	2,980.44
Total		$ 8,932.44
Volta Memorial Fund:		
Dominion of Canada, externals 3%, due 1963	$ 1,000.00	$ 1,003.75
U. S. Treasury bonds 2½%, due December 15, 1962/59	16,000.00	15,450.00
Total		$ 16,453.75
Total		$760,492.10

OF CURRENT INTEREST

Telephone Sets in Color and Light for Night Dialing Are New WE Features

The *500*-type telephone set, first introduced on a field trial basis in selected areas of the United States in 1948, now will be available in eight different colors. Designed as a successor to the familiar *302*-type combined set, the *500* type with its improved transmission, dialing, and ringing performance characteristics has been manufactured of black plastic in the Western Electric Company's Indianapolis (Ind.) Works since 1950. To make the additional colors available to the subscriber has required months of concentrated research and study by both Bell Telephone Laboratories' and Western Electric engineers.

Many problems encountered in the selection of the proper plastic material, the designing of the special tools and dies, and the handling of the colored plastic compound had to be overcome before colored telephone sets, capable of meeting Bell System standards, could be put on a production basis. For example: although phenol plastic compound is ideally suited for compression molding the black handset, exhaustive tests indicated that to produce colored handsets with the desired physical characteristics a change in both molding compound and molding process would be necessary. The studies revealed that cellulose acetate butyrate, a thermoplastic of the cellulose compound family, with excellent molding qualities and unlimited color possibilities, would serve equally well for both the telephone handset and base.

Conveyor belt speeds assembly of 500-type colored telephone sets at Western Electric Company's Indianapolis Works

However, the change from the compression molding method to the injection molding process for the handset presented mold design problems. Because successful molding of thermoplastic materials calls for a design having thin walls of uniform thickness, the engineers had to redesign the inner contour of the handset to obtain the desired wall dimensions in order not to interfere with the extraction of the inner molding die. However, in correcting this condition by enlarging the opening through the handle, the acoustical properties of the receiver were altered. This, fortunately, was quickly solved by the insertion of sound-absorbing material into the hollow portion of the handle. In overcoming the many problems caused by the introduction of color, the engineers not only developed an improved die which eliminated several steps in the manufacturing operation but produced a lighter and more convenient handset.

The *500*-type set must pass rigid tests, both physical and electrical. Shown on the cover is a photograph of the transmitter and receiver test. The colored telephone handset is in position against the test fixture which provides the proper transmitter-artificial mouth (transducer) and receiver-artificial ear (capacitor microphone) acoustical loading required to simulate the conditions of normal use of the handset.

Alongside is a small key cabinet for circuit switching and for connection to the handset cord. The main test unit (not shown on cover) houses the electronic circuits and cathode-ray tube for the display of the electrical output characteristics of the transmitter and receiver. An audio warble voltage is initially applied to the artificial mouth and the transmitter response is presented as vertical CRO (cathode-ray oscilloscope) deflection on a linear decibel scale. A visual presentation of the response level versus frequency is achieved through the simultaneous application of a horizontal sweep voltage proportional to the logarithm

500-type set features a light that illuminates the dial when the handset is lifted

Future Meetings of Other Societies

American Institute of Chemical Engineers. National Meeting. September 12–16, 1954, Hotel Colorado, Glenwood Springs, Colo.

American Transit Association. Annual Meeting. September 27–30, 1954, Hotel William Penn, Pittsburgh, Pa.

Association of Iron and Steel Engineers. Annual Meeting. September 28–October 1, 1954. Cleveland Public Auditorium, Cleveland, Ohio

Canadian Electrical Manufacturers Association. 10th Annual Meeting. September 22–24, 1954, Sheraton-Brock Hotel, Niagara Falls, Ont., Canada

Conference on Fire Protection Engineering. August 17–19, 1954, Massachusetts Institute of Technology, Cambridge, Mass.

Illuminating Engineering Society. National Technical Conference. September 12–16, 1954, Chalfonte-Haddon Hall, Atlantic City, N. J.

Institute of the Aeronautical Sciences. Turbine-Powered Air Transportation Meeting. August 9–11, 1954, Seattle, Wash.

Instrument Society of America. 1st International Instrument Congress and Exposition. September 15–21, 1954, Convention Hall, Philadelphia, Pa.

International Association of Electrical Leagues. September 29–October 2, 1954, Bellevue Stratford Hotel, Philadelphia, Pa.

International Electrotechnical Commission. Golden Jubilee Meeting. September 1–16, 1954, University of Pennsylvania, Philadelphia, Pa.

Joint Electron Tube Engineering Council. General Conference. September 16–18, 1954, Chalfonte-Haddon Hall, Atlantic City, N. J.

Pan-American Federation of Engineering Societies (UPADI). 3d Convention. August 2–12, 1954, Sao Paulo, Brazil

Society of Automotive Engineers. National Tractor Meeting and Production Forum. September 13–16, 1954, Hotel Schroeder, Milwaukee, Wis.

Society of Automotive Engineers. West Coast Meeting. August 16–18, 1954, Hotel Statler, Los Angeles, Calif.

The American Society of Mechanical Engineers. Fall Meeting. September 8–10, 1954, Hotel Schroeder, Milwaukee, Wis.

West Coast Electronic Manufacturers Association and Institute of Radio Engineers, Los Angeles and San Francisco Sections. West Coast Electronic Show and Convention. August 25–27, 1954, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.

of test frequencies. An associated circuit also automatically checks for compliance with the allowable values of transmitter resistance.

The warble voltage is then transferred to the receiver and the output level and frequency response is likewise presented on the screen of the CRO tube. The 60-cycle impedance of the varistor associated with the receiver is next measured by direct comparison on the CRO tube scale. Output levels are decibels versus 1 volt (open circuit) at a specified sound pressure for the transmitter and decibels above 1 dyne per square centimeter per watt of available power for the receiver. The testing circuits were designed by Bell Telephone Laboratories and developed for production testing at the Indianapolis Works of Western Electric.

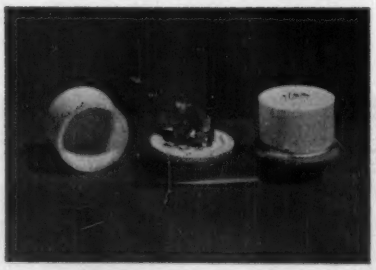
Another new development in *500*-type telephones is the illuminated dial set, coded the *500H*. Designed by Bell Laboratories and about to go into production at Western Electric's Indianapolis Works, this modification of the *500* set features a tiny electric light bulb that casts a glow over the dial whenever a subscriber lifts the handset.

Except for the dial light and the substitution of a transparent finger wheel that distributes light evenly over the dial number plate, the telephone is the same as the regular *500*-type set. The lamp is a flashlight-type bulb powered by a small 6-volt transformer which plugs into the standard household current and fastens on wall.

Stack-Mounted Electron Tubes Provide Stability Under Extreme Conditions

A new concept of an electron tube, believed to have vast potentials, was announced recently by Sylvania Electric Products Inc. The new development, known as the "stacked tube," is the result of several years' study by the Sylvania Research Laboratories, culminating in a development contract with the U. S. Navy's Bureau of Ships, and limited quantities are now being made at the company's Product Development Laboratories, Kew Gardens, L. I.

The new tube features a ceramic envelope or cap, instead of the usual glass bulb, and the various parts are "stacked" one atop the other in the assembly process, a procedure radically different from conventional methods. A further feature is the use of ceramic spacers, instead of mica. These design innovations not only make possible the tube's unique performance and reliability, but also enable high mass production because of design simplicity. The first use of the new tubes will be military, but they will eventually become available for other applications.



The compactness of a "stacked tube," developed by the Research Laboratories of Sylvania Electric Products Inc., is demonstrated by comparison with an ordinary book match. The assembly, center, shows a "mount" on which the tube components have been stacked by automatic production methods. This assembly and the ceramic envelope, left, are placed in a "bell-jar" device in which the tube is baked out, air-evacuated, and sealed. The finished tube is at the right

In explaining the details of the new tube, Dr. Bennett S. Ellefson, director of research for Sylvania, said that assembly is a simple stacking operation and that sealing is done with a "bell-jar" system, a glass dome under which the stacked parts are placed, air-evacuated, and the tube envelope sealed over the stacked parts. These stacking, sealing, and evacuating procedures, he said, not only provide extremely high ruggedness but also lend themselves to completely automatic production methods, which make possible large volume and a high degree of uniformity.

Commenting on the new tube's unprecedented ruggedness, or a greater ability to withstand shock and vibration without deterioration of performance, Dr. Ellefson said that contributing to this ruggedness is the substitution of ceramic spacers for mica spacers. In extreme operating conditions, mica has a tendency to spall and flake under vibration and shock, causing mechanical failure of the tube, he pointed out.

The complete mount of the new tube, he pointed out, is assembled on two small pins. First a plate, a spacer ceramic, a grid, a spacer ceramic, a cathode, a spacer ceramic, and so on until the top is reached. When the stack is completed, the small pins are then electrically riveted, giving a compact tight mount assembly.

In exploring the feasibility of using ceramic for spacers, stems, and envelopes, considerable development was necessary, Dr. Ellefson said, to obtain a vacuum-tight ceramic and make ceramic-to-metal seals that eliminated complex and critical techniques.

The ceramic material used for the envelope and stem is aluminum oxide. Sealing the envelope and stem together is a single-step process. No mica is used in the mount, and therefore it can be placed on a ceramic stem and sealed in a ceramic envelope under temperatures of about 950 C, substantially higher than mica can withstand.

Aside from sealing the tube, this process also provides a high "baking-out" temperature which sealing glasses could not withstand. The finished tubes consequently have less gas to begin with, and, therefore, have a longer gas-free life. The new tubes made to date, he said, indicate that when manufactured in this way, they meet all the physical and electrical objectives in addition to the automatic machine assembly concepts.

The ceramic envelope is much stronger than the glass envelope, and the tube can be handled, dropped, and shipped without breakage. The ceramic envelope is also extremely rugged under widely fluctuating temperature conditions. It has been removed from liquid nitrogen at −195 C and immersed in boiling water at +100 C, a range of almost 300 C, without fracture. Tubes have been thermally cycled from room temperature up to 450 C without damage.

The tube can be strapped directly to the equipment chassis, or it can be socketed. Lead wires can be soldered directly to the pins.

ASEE Urges More Teaching of Basic Sciences, Humanities

Engineers should become more scientific, more creative, and more human. This evaluation of today's engineering teaching was the domimant theme of the 62d annual meeting of the American Society for Engineering Education (ASEE), June 14 to 18, 1954, at the University of Illinois.

More than 1,400 engineers registered for the meeting. They urged each other to devote more time to the basic sciences, engineering science, and the humanities—at the expense of teaching engineering art or practice.

Industrial employers, agreeing with the educators, said that they were unwilling to have colleges sacrifice the sciences and humanities to provide time for studying technology or administration. They insisted that their sales, manufacturing, and operating departments as well as their research and development divisions, need engineers with strong scientific backgrounds.

The extent of this move to strengthen science is shown by the proposal in an interim report of the ASEE's Committee on Evaluation of Engineering Education. This proposal would have all engineering students, whether majoring in chemical, mechanical, electrical, civil, or other branches of the field, study in common almost five sevenths of the total course. Only two sevenths would be concentrated in the field of the major, and almost half of this would be as elective courses.

In his principal address of the meeting, Dean Linton E. Grinter of the University of Florida, retiring president of the ASEE, said that colleges "must experiment with all possible methods of orienting engineering education more significantly toward basic and engineering science." Dean Grinter said that the engineer must be inherently creative, putting together a combination of theories, concepts, techniques, and experience in new and productive patterns.

The emphasis on science was continued by Dr. Lee A. DuBridge, president of the California Institute of Technology, who spoke at a celebration of the 50th anniversaries of the engineering experiment stations at the University of Illinois and at Iowa State College. "Maintain a close tie with the basic sciences," was Dr. DuBridge's advice. "An engineer, after all, is putting to practical use today what scientists discovered yesterday." Still more important, Dr. DuBridge stressed, is the fact that the work he must do tomorrow will

grow out of what the scientist is working on today.

Despite the high purposes of science, too few high school students are being led to a study of science according to Major Lenox R. Lohr, president of Chicago's Museum of Science and Industry. Major Lohr told the attendants at the annual banquet of the society that only 4 per cent of Chicago high school students are studying physics and no more than $1^1/_2$ per cent are studying solid geometry.

Other highlights of the meeting included:

The demand from industry and government for new engineering talent continues to be greater than the current supply. Donald S. Bridgman of the American Telephone and Telegraph Company reported a national survey indicating that the decline in business activity and defense orders in 1954 has led to a 20-per-cent decrease in the need for engineering graduates. But, he said, "with the relatively small classes graduating at this time, there is still substantial unfilled demand."

Dr. Eric A. Walker, dean of engineering at the Pennsylvania State University and chairman of the Engineering College Research Council, pointed out that "The colleges of engineering of the United States must be allowed to get into atomic research if they are to support and conduct a vigorous and up-to-date educational program preparing for careers in the general field of atomic energy."

Richard W. Schmelzer, assistant to the president at Rensselaer Polytechnic Institute, and chairman of the ASEE's Committee on Incentives for Good Teaching, proposed this formula for adding to the stature of college teaching in America:

"We need to create a climate of opinion so that the man who devotes himself primarily to teaching won't feel apologetic about it—won't feel that he is not a valued member of the university community; won't feel that he is playing second fiddle to a researcher or a writer of textbooks; won't feel that it is somewhat futile to devote his efforts to making himself as good a teacher as he possibly can."

A special ASEE project to study the teaching of humanities and social sciences to engineers, financed by a $30,000 grant from the Carnegie Corporation, was begun at the University of Illinois with a 2-day workshop session. The goal of the project is to recommend ways by which engineering students' work in these liberal arts subjects may be strengthened. During the next several months teams of field workers will visit campuses to study the programs now under way at each school and to estimate their effectiveness. Edwin S. Burdell, president of the Cooper Union, New York, N. Y., is project chairman.

Analog Computation Center Available on Rental Basis

The first Analog Computation Center, available to industry on a rental basis, was opened July 14, 1954, near Princeton, N. J., by Electronic Associates, Inc., to meet the demand for an eastern headquarters where members of industry may rapidly solve complex problems in management operations control, dynamic systems analysis, and

The analogue computer installed at the Electronic Associates Analog Computation Center near Princeton, N. J.

applications engineering. The Center is equipped with electronic analogue computer equipment, and will be staffed with scientists experienced in the use and applications of analogue computers. These specialists will be available to industry and business to help solve the problems submitted.

The Center is equipped with a dual control console and related equipment. This permits the simultaneous solution of two problems or the use of the entire facility to solve more complicated problems.

In announcing the establishment of the Center, Lloyd F. Christianson, president of Electronic Associates, Inc., said: "We feel that there is a growing need in industry for a facility such as we have established near Princeton. The analogue computer there can save industry untold man-hours. It will prove particularly beneficial to the smaller companies which have not yet found it feasible to invest in their own computation facilities."

To each problem, the Center will assign scientists, engineers, or mathematicians. When individual situations require specialized aid, the staff will be augmented by additional scientists from various research institutions and universities in the area and from Electronic Associates in Long Branch, N. J.

Customers may set up their problems themselves, either at their own plant or at the Center, by using the special problem boards available for that purpose.

AEC Releases Bibliographies of Interest to Industry

A new series of bibliographies, "Selected AEC Reports of Interest to Industry," has been compiled and released by the Atomic Energy Commission (AEC) to help American industry judge its interest in nonsecret literature reporting technology developed in the atomic energy program.

The new bibliography series selects from nearly 9,000 unclassified research and development reports issued prior to July 1953, about 800 reports considered of particular interest to industry. This selection of reports is divided into industry categories, published as individual sections of the bibliography series.

The entire set, or individual sections of the series, may be purchased from the Office of Technical Services, Department of Commerce, Washington 25, D. C. Cost of the set is $2.25, while costs of individual sections are: Chemistry and Chemical Engineering 45¢; Construction and Civil Engineering, Mining and Geology 25¢; Electronics and Electrical Engineering 35¢; Health and Safety, Industrial Management 25¢; Mechanics and Mechanical Engineering 25¢; Metallurgy and Ceramics 35¢; and Nuclear Technology 35¢.

Many of the reports abstracted in the bibliographies may be purchased in full from the Office of Technical Services, or may be inspected at the 40 regular AEC depository libraries located throughout the United States. Additionally, special industry information depositories are also being established in strategically located cities. To date, the Atomic Industrial Forum, Inc., 260 Madison Avenue, New York, N. Y., and the John Crerar Library, 86 East Randolph Street, Chicago, Ill., have been designated such depositories.

Thorndike Saville Awarded 1954 Lamme Medal of the ASEE

Dr. Thorndike Saville, dean of the College of Engineering at New York University, received the Lamme Medal of the American Society for Engineering Education (ASEE) at the society's annual convention.

The Lamme gold medal and bronze replica are awarded annually to a distinguished engineering educator "for excellence in teaching and contributions to the art of teaching, and achievements which contribute to the advancement of the engineering profession." Dean Saville is a former president of the ASEE.

Previous winners of the award, established in 1928, include Karl T. Compton, William E. Wickendon, and Stephen P. Timoshenko.

In 1953 the medal was given to Harry S. Rogers, president of the Polytechnic Institute of Brooklyn.

Head of New York University's College of Engineering since 1936, Dean Saville is also president of the Engineers Joint Council. He is a member of the U. S. Beach Erosion Board, chairman of the Committee on Education of the Engineers' Council for Professional Development, and engineer member of the New York State Public Health Council.

As an engineer, consultant, and research scientist, Dean Saville's contributions lie in the fields of hydrology, water supply, and coastal engineering.

He has served as chairman of the Engineering Panel on Future Water Supply for New York City, executive engineer of the Water Resources Section of the National Resources Board, adviser to the Public Works Committee of the first Hoover Commission, and consultant to the National Science Foundation.

Dean Saville was born in Malden, Mass. Before coming to New York University, Dean Saville was professor of hydraulic and sanitary engineering at the University of North Carolina. He also served as chief engineer for the North Carolina Geological Survey, in charge of investigations involving stream gauging in the state, water power surveys, mapping of state lakes and parks, stream pollution, beach erosion, and drainage district administration.

Expandable Truck Trailers Serve as Navy Classrooms

The U. S. Naval Air Mobile Training Detachment has put into operation classrooms on wheels, which will give the smaller auxiliary naval air training bases the same advantages as were previously only available to the larger aviation installations.

These traveling classrooms are installed in a new type of specially built truck-trailers, designed and engineered for the Navy by engineers of Trailmobile Inc.

Because state and national laws restrict the width of vehicles on the highways to 8 feet, these expandable trailers have been built with side-walls that can be moved out, by one man with a crank, from the trailer's normal width of 96 inches, until they form the side-walls of a room 20 feet square in inside dimensions.

In this 20-foot-square classroom, as many as 40 men can be seated comfortably, but classes will be limited to about 15 men each.

The expandable trailers, it was pointed out, serve not only as traveling classrooms, but also provide transportation from base to base of the equipment and mechanical parts used by instructors in training aviation specialists, thus serving a dual purpose.

Three of the expandable trailers are to be used by the Memphis, Tenn., detachment. One has been sent to San Diego, Calif., to work out of the base there. Another has been sent to Norfolk, Va., and a third will be sent to Jacksonville, Fla.

In these classroom trailers, instructors teach the munitions, ordnance, and rearming phases of aviation. A total of eight phases or 720 hours of instruction covering administrative ordnance; aircraft guns and accessories; ordnance electricity; aircraft fire control equipment; aircraft turrets; releasing, launching, and related equipment; munitions; and rearming can be taught in the trailer classes.

Combat-Type Aircraft Built in Sections for Assembly Later

New techniques in design, manufacturing, and shipment are making U. S. Air Force *B-61* Martin Matador pilotless bombers immediately available for use by the Air Force wherever they are needed throughout the world.

For the first time in the history of the aircraft industry, a combat-type aircraft is being built in sections which are assembled in the field.

Packed in weatherproof crates, the seven major parts of the Matadors are easily shipped as separate units. These are not assembled until just before launching. Final assembly may take place thousands of miles from the Baltimore, Md., plant where they are manufactured and even years after they leave the assembly line.

The Matador's seven parts are completely interchangeable. Into easily transported crates go the nose, wing, center section, aft tail, fin, and bullet fairing stabilizer sections,

Assemblies in which the B-61 Martin Matador is manufactured. These components are weather-proofed and crated for assembly and use later

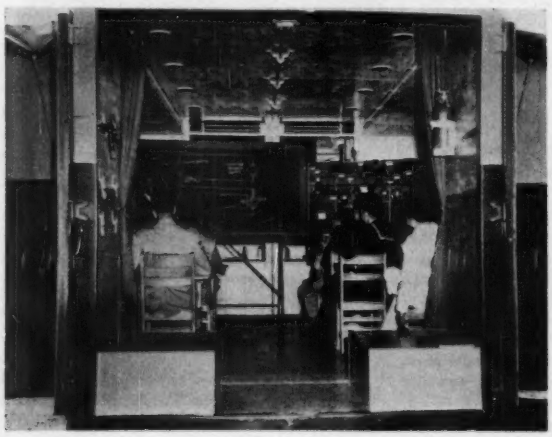
and the instrumentation. No two pieces must be made expressly for each other. The undistinguished looking crates can be stacked and stored for long periods of time. Or they can be transported from place to place with ease.

The first successful ground-to-ground pilotless weapon developed for the Air Force and the first pilotless weapon of any kind sent overseas for duty, the Matadors are now on duty in Germany. The first of two pilotless bomber squadrons has completed its training at the Missile Test Center at Cocoa, Fla., and is now in Europe.

Easily shipped and assembled, the Matadors are also easily launched. They are sent aloft from the world's smallest airport—a highly mobile launcher barely as long as the craft themselves and narrower than the Matador's wing spread.

Elevated to launching angle, the Matador's turbojet engine is aided on take-off by a rocket booster. The craft is air-borne in its own length. Thrust upward at terrific speed, the Matador drops its rocket booster as soon as the booster's power is exhausted.

Under power of its turbojet, the Matador streaks along at speeds comparable to the Air Force's latest jet fighter planes. When the Matador dives on its target, it passes through the sonic barrier.



Center section of the interior of a portable classroom housed in an expandable truck trailer. Parts of the expanded trailer sides can be seen at extreme right and left in the picture

Portable Radio Serves as Marine Direction Finder

A new portable radio which serves also as a marine direction finder to help boatsmen determine their positions at sea, has been announced by Raytheon Manufacturing Company. It receives the regular AM broadcast band, and also "Marine" and "Beacon" bands.

The new model, the *GM 114A*, looks very much like an ordinary portable radio, with no unsightly radio loop rising from the top, like other radio direction finders. Instead, a flat, knob-like antenna projects only 2 inches above the case. The whole radio weighs only 13 pounds, including batteries, and measures 12 inches wide by 7 inches deep and high.

The boat owner may listen to his favorite radio program or good music, and at the same time, rotate the antenna until it points directly at the radio station. In this way, the mariner may obtain a "fix" showing his exact position at sea, using ordinary commercial radio stations. In addition, he may tune in the 1,700–3,400-kc Marine frequencies to locate vessels operating radiotelephones and to obtain weather information. The set also receives the 200–415-kc Beacon band, enabling the boat owner not only to make extremely accurate fixes, but also to locate light ships and danger points marked by government beacons.

Wireless Microphone Permits Free Movement by TV Performers

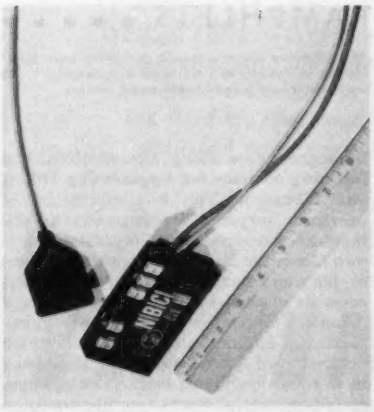
A tiny wireless microphone that can be concealed on the person of television performers was demonstrated recently by the National Broadcasting Company (NBC).

The NBC-developed microphone, with an accompanying midget transmitter and antenna which can also be concealed in the performer's clothing, permits freedom of movement on a scale not possible with conventional microphones using cables and booms.

The signal put out by the tiny transmitter is picked up by a loop of wire encircling the work area. In the case of outdoor programs, the loop can be laid on the ground, suspended from trees, or draped in bushes.

The entire assembly—microphone, transmitter with battery, and loop antenna—weighs slightly less than 8 ounces. Small size of the unit is made possible by the use of transistors. Eight transistors are used in the transmitter.

The transmitter, when its design is finalized, will be little larger than a pack of king-sized cigarettes. The laboratory model used in the demonstration is somewhat larger, in order to facilitate circuit development. Eventual dimensions of the transmitter will be 1/8 inch by 2 inches by $3^3/_4$ inches.

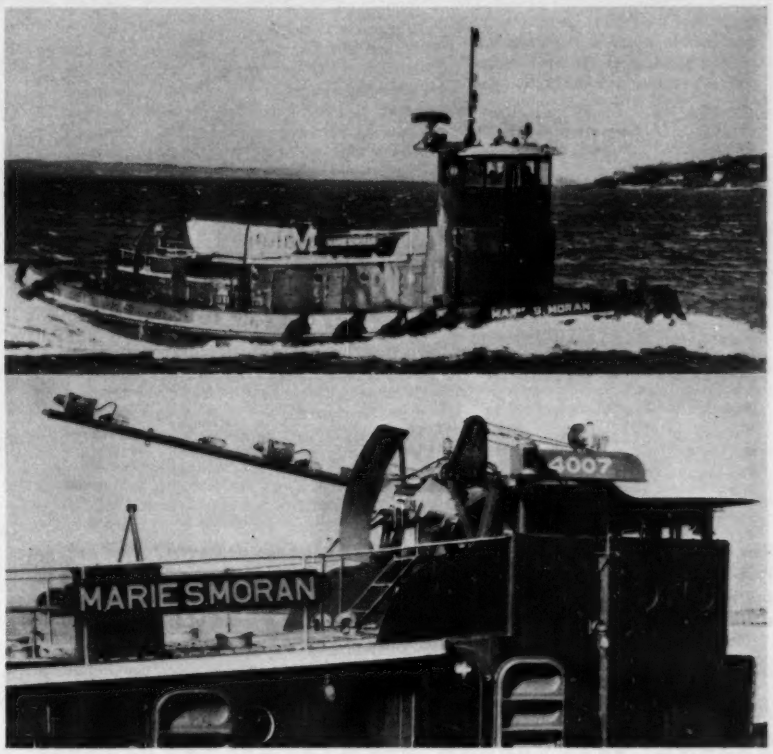


Tiny wireless microphone and transmitter developed by NBC. Signal is transmitted from antenna worn around performer's waist, and is picked up by loop encircling stage area

The range of reception of the miniature transmission has not yet been fully determined, but tests have shown no difficulty in covering an area of 5,000 square feet, NBC engineers said. They added that the system is not vulnerable to most sources of interference, but in areas where interference might be a problem, an increase in received signal can be achieved by reducing the area covered by the receiving loop, thereby improving the ratio of signal to noise from the transmitter.

The transmitter is powered by an alkaline cell battery which is expected to furnish 5 hours of continuous, reliable transmission. The unit develops approximately 50 milliwatts of power at about 530 kc, but radiates less than 100 micromicrowatts. Because of the low power and low frequency, the transmitter does not require licensing, since it is well below the limits prescribed by the Federal Communications Commission for such devices.

Retractable Radar and Wheelhouse



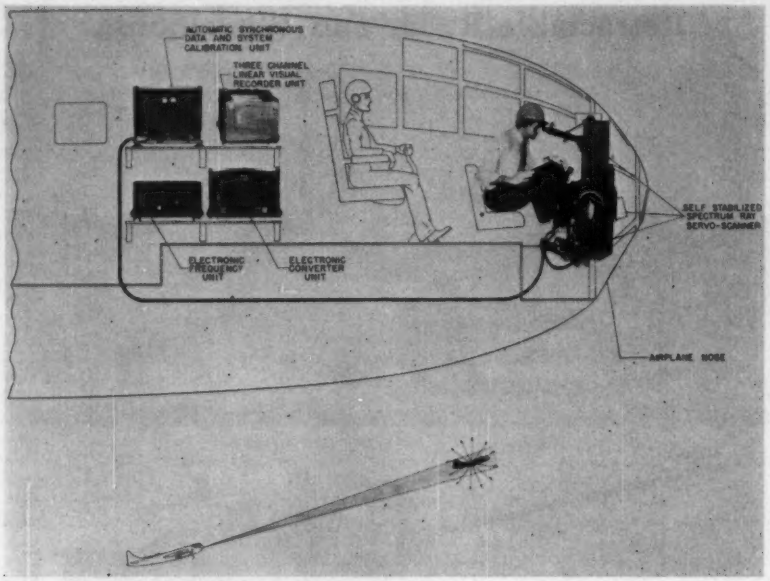
(Top) Small-size radar unit, the "Mariners Pathfinder" Model 1500, mounted on mast of Marie S. Moran, permits lowering of the mast horizontally and retraction of the wheelhouse for clearing low bridges. The radar, built by Raytheon Manufacturing Company, Waltham, Mass., is the first successful commercial unit of its kind to eliminate rigid waveguide for conducting radar signals. Transmitter and receiver are built in the antenna housing and only a flexible cable runs from this assembly to the indicator in the cabin. (Bottom) The tugboat lowers her mast and retracts her wheelhouse a distance of 7 feet to pass under low bridges. The upright mast tilts backward until it lies horizontally above the deck. Once clear of the obstruction the vessel's air and oil hydraulic ram rig extends the telescoping wheelhouse again and erects the mast. Throughout this maneuver, the radar unit remains intact and operative

Flying Laboratory Analyzes Radiations From Aircraft

Servo Corporation of America has delivered to U. S. Air Force engineers a completely automatic flying laboratory. This laboratory is capable of scientifically measuring and analyzing invisible radiations emanating from any missile or aircraft in flight. It will make these measurements up at the highest altitudes where only clear, cold blackness prevails. All aircraft and missiles in flight radiate energies in many wavelengths. These rays can be "smelled" by enemy aircraft and act as a fatally telltale form of "body odor."

The Air Forces' new flying science laboratory is only one of 30 major equipments that this company has created for the Armed Forces. These equipments are all in the new field of infrared radiation and measurement.

In order to make possible these tremendous contributions to national defense, Servo


AUTOMATIC SYNCHRONOUS DATA AND SYSTEM CALIBRATION UNIT
THREE CHANNEL LINEAR VISUAL RECORDER UNIT
SELF STABILIZED SPECTRUM RAY SERVO-SCANNER
ELECTRONIC FREQUENCY UNIT
ELECTRONIC CONVERTER UNIT
AIRPLANE NOSE

The stratosphere electronic-ray laboratory which has been delivered to the Air Forces Radiation Laboratory incorporates a gyro-stabilized platform to prevent aircraft bouncing from disturbing precise measurements. The electronic ray analyzer is a precision double monochromator capable of splitting the colors of a band of black light 50 times wider than the band of visible light

Corporation of America had to create new optical materials known as Servofrax* glass and new infrared detection devices known as Servotherm* thermistor bolometers.

The Air Forces' flying infrared laboratory is gyro-stabilized in space. At the flick of one of 24 switches, all kinds of different scientific measurements can be made rapidly and automatically on whatever the target aircraft may be. The data taken in these measurements are valuable in guiding aircraft and military designers to reduce vulnerability to enemy attack. They also fix quantitatively the basic physical energies, below which no aircraft can go in concealing its presence from this passive "body-odor" type of infrared radiation.

The flying laboratory is sufficiently compact and light to fit into the bombardier's compartment of a medium bomber. It includes complete intercommunicating facilities with other engineers and scientists in the crew.

* Trade-mark

New Material to Aid Cancer Research Produced at Oak Ridge

Development of a new isotope material that may become an important factor in cancer research has been announced by Arthur F. Rupp, director, Operations Division, Oak Ridge National Laboratory. For the first time in scientific history, large quantities of the radioisotope Cesium 137 have been separated and compressed into pellets.

The Cesium 137, which is the most important long-lived gamma-ray emitting isotope found in spent reactor fuel, was chemically separated from fission products available at the Laboratory. The first cesium pellets will be used as a radiation source in a new teletherapy unit being prepared for cancer research in the Medical Division of the Oak Ridge Institute of Nuclear Studies. "Large quantities" of high-purity Cesium 137 means just these two pellets, each about the diameter of a half dollar—1/2 inch thick and weighing a little more than an ounce. The two pellets contained 1,540 curies of radioactivity, equivalent in radiation energy to more than 1 pound of radium, which at current rates would cost more than $1,000,000.

In preparing the pellets, dry powdered cesium chloride was placed in a die in a hydraulic press and subjected to a pressure of 20,000 pounds per square inch. The pressing operation was repeated, producing two pellets, each slightly over 1/2 inch in height, 1 1/4 inches in diameter, and averaging a little over 1 ounce each in weight.

After pressing, the pellets were placed in the stainless steel jacket which was closed by silver soldering. This jacket, with its potent contents, was in turn sealed into another outer stainless steel jacket in order to be doubly sure of obtaining a leakproof container.

The new source was held for observation at the Laboratory until July, at which time it was installed in the Oak Ridge Institute of Nuclear Studies teletherapy unit, and the institute has officially assumed title to it. It is expected that some time will be spent evaluating the Cesium 137 source before it is used in cancer research.

Cost of Cesium 137 sources cannot be determined from the results of the primary production, but it is hoped that in volume production the price can be brought down to a level where it will be competitive with other radioactive sources such as Cobalt 60.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ELECTRONICS. By A. T. Starr. Sir Isaac Pitman and Sons, Ltd., London, England (distributed by Pitman Publishing Corporation, 2 West 45th Street, New York 19, N. Y.) 1954. 395 pages, 8 1/4 by 5 1/4 inches, bound. $7.50. Physical and mathematical aspects of electronics are stressed in this textbook for engineering students and for those preparing for professional examinations. Fundamentals, tubes, rectification, and circuit theory are considered in separate chapters, and one chapter covers amplifiers, oscillators, and detectors. Applications in control systems, timing and counting, high-frequency heating, and in other fields are also discussed.

ELECTRONICS. By George F. Corcoran and Henry W. Price. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1954. 495 pages, 9 1/4 by 6 1/4 inches, bound. $7. Designed for a first course for junior students, this text emphasizes circuitry aspects of the subject but does not neglect basic principles. It includes chapters on vacuum-diode operations and mobile charges, conventional material on linear and nonlinear operations, and chapters on feedback circuits, germanium diodes, transistors, and oscillators.

ENGINEERING CONTRACTS AND SPECIFICATIONS. By Robert W. Abbett. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1954. 429 pages, 8 3/4 by 5 3/4 inches, bound. $6. Legal and business aspects of the engineering profession are presented in this book which has been revised and expanded throughout. Material on contracts, specifications, and the presentation of legal rights and obligations in construction work has been considerably amplified, and other sections have been rewritten in the light of current professional practice.

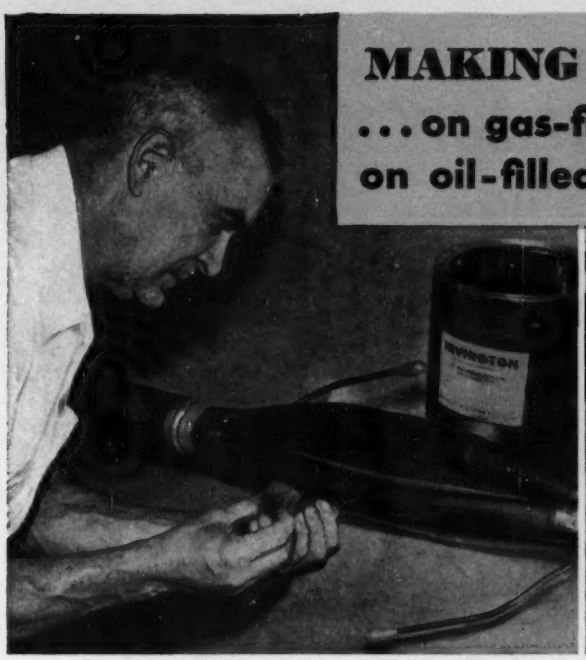
A GUIDE TO TECHNICAL WRITING. By W. George Crouch and Robert L. Zetler. Ronald Press Company, 15 East 26th Street, New York, N. Y., second edition, 1954. 441 pages, 8 3/4 by 5 3/4 inches, bound. $5. This book, designed for both undergraduate students and those in industry, is concerned with the use of competent English in business letters, in technical reports, letters, and articles, and in formal and informal oral communications. In the present edition the order of presentation has been altered and new specimen reports, memoranda, etc., have been added.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Bibliography on Filing, Classification, and Indexing Systems for Engineering Offices and Libraries. This is a selected list of references prepared for engineers an dlibrarians concerned with organizing their own files or the files in the engineering offices or libraries where they work. The references are to articles in magazines, books, and pamphlets on filing, classification, and indexing, lists of subject headings, and hand-sorted punched-card systems suitable for organizing small collections of engineering books, notes, correspondence, abstracts, reprints, drawings, maps, catalogues, etc. Some of the listed items are general; some relate to specific subject fields. 79 annotated references. 18 pages. $2.00. Available from the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

MAKING SPLICES ...on gas-filled cable? on oil-filled cable?...



Crepe paper applied on one leg of 27 K.V. — 3 conductor — 500 M.C.M. paper insulated, gas filled cable.

Oil-immersed Varnished Cambric applied on 27 K.V. — 3 conductor — 500 M.C.M. paper and lead solid type cable.

Select your insulating tapes from the complete Irvington line

For gas-filled cable, use Irvington vacuum treated, oil impregnated Crepe Paper No. 4000 — packaged in cans to meet your specific requirements for number and size of rolls. *Whenever* your needs for crepe paper are not fully met by packaged splicing kits, make Irvington your source of supply.

For oil-filled cable, use No. 5000 Yellow or No. 5500 Black Low Loss Varnished Cloth Tape — both packaged under vacuum. Or if you prefer, choose No. 6000 Yellow or No. 6500 Black Oil Immersed Varnished Cloth Tape.

OTHER IRVINGTON PRODUCTS FOR UTILITIES: *For moisture-proof, oil-tight cable splices and stop joints* on rubber, paper or cambric insulated cable, use No. 621 Harvel Oil Stop. *And for an oilproofing finishing coat* over bus bar wrappings — or for sealing pipeline joints and gaskets — apply No. 32 Red Enamel.

Look to
IRVINGTON
for Insulation Leadership
INSULATING VARNISHES
VARNISHED CAMBRIC
VARNISHED PAPER
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CLASS "H" INSULATION

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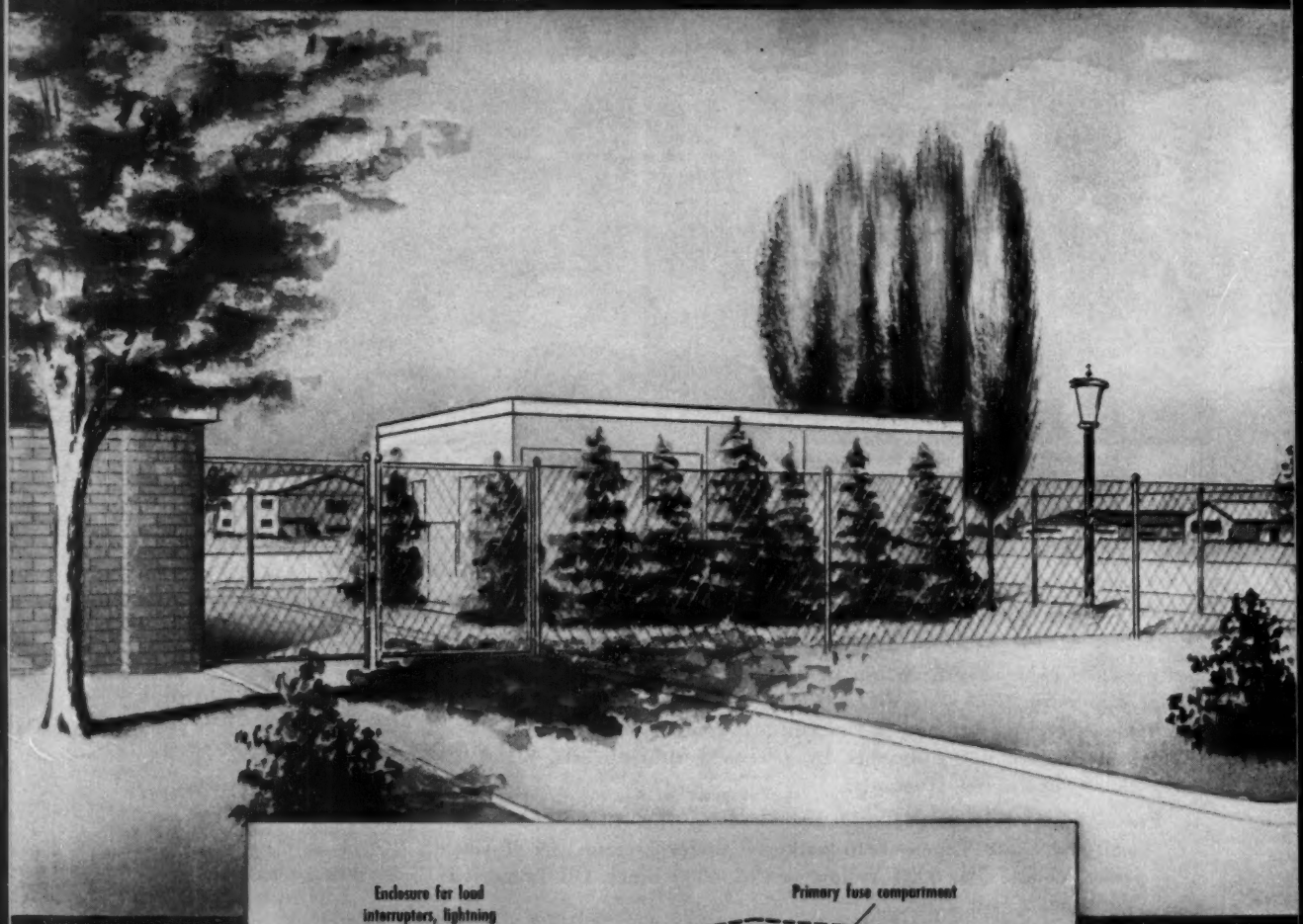
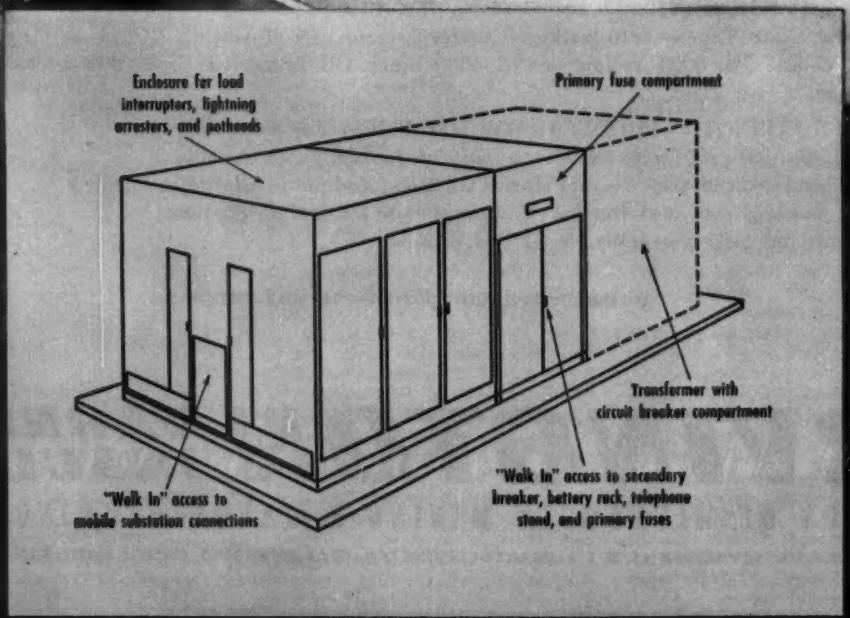
32 ARGYLE TERRACE, IRVINGTON 11, N. J. • PLANTS: IRVINGTON, N. J.; MONROVIA, CALIF.; HAMILTON, ONTARIO, CANADA




Enclosure for load interrupters, lightning arresters, and pothoods
Primary fuse compartment
Transformer with circuit breaker compartment
"Walk in" access to secondary breaker, battery rack, telephone stand, and primary fuses
"Walk in" access to mobile substation connections

Neighborhood Acceptance?

Plus

-
-
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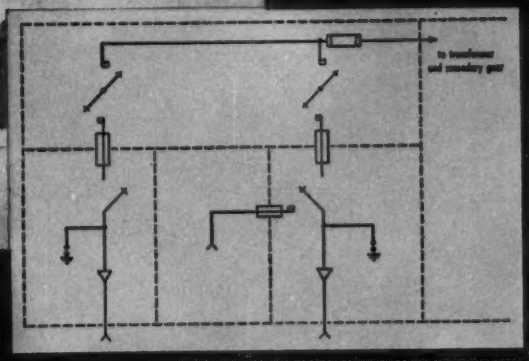
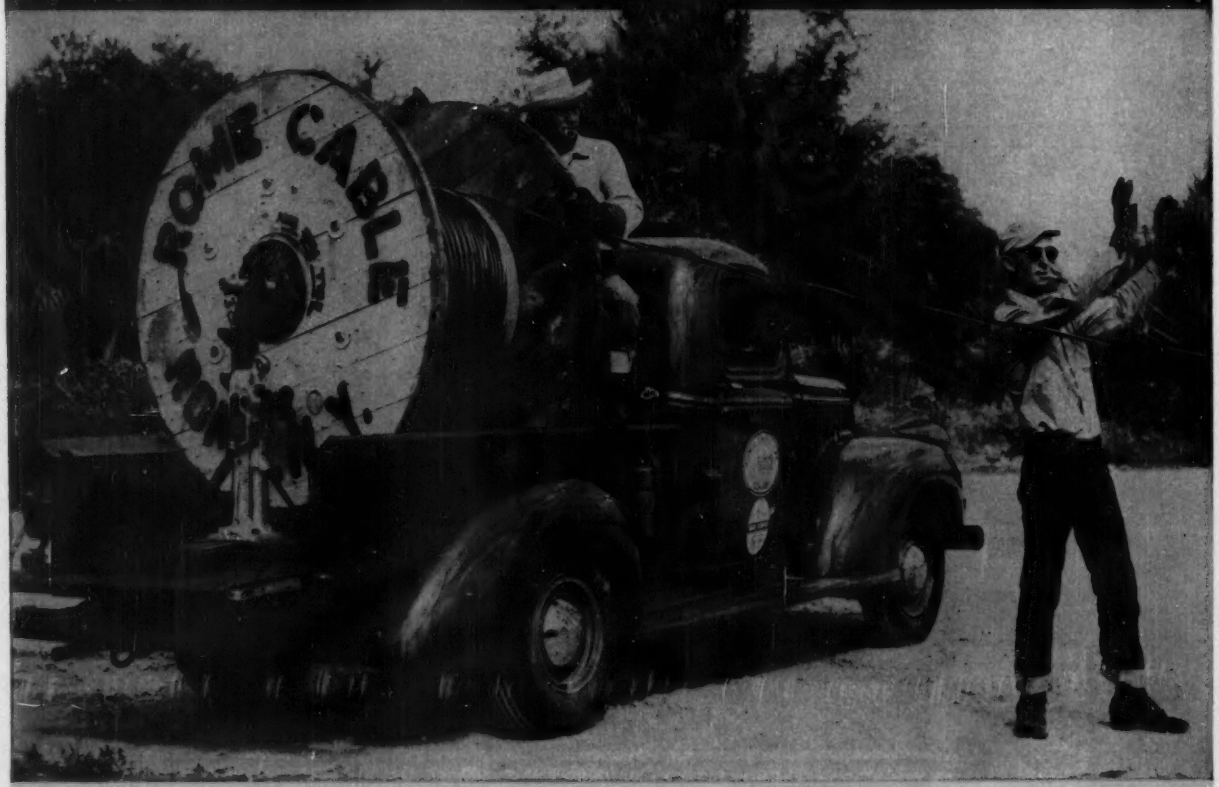
-



S&C



Top: Florida Power & Light's attractive new power giant, the Cutler plant, serving Miami.

Bottom: Rome Triplex service drop cable being reeled out to provide service to another of over 36,000 new FP&L customers.

Problem:
Keeping ahead of power demands in fast-growing Florida

How FP&L uses Rome Cable to aid its expansion program

The whole state of Florida's in high gear, rolling up records for expansion and growth . . . 1,000,000 population for Miami by 1962; mineral production up 74%; value of manufacturing up 84% . . .

All this spells progress and prosperity enough to put smiles on Chamber of Commerce faces and gladden the heart of the Sunshine State's growing utility, Florida Power & Light Company. But for FP&L it also poses a pressing problem—*keeping ahead* of the *power demands* imposed by skyrocketing growth.

Solution—To meet this challenge FP&L has underway a ten-year expansion program costing $332,000,000. And Rome Cable has been approved by FP&L engineers for many of their important installations, such as their new plant at Cutler.

The Cutler plant is one of five serving the greater Miami area. There, and at other installations, reel after reel of Rome RoZone-RoPrene power and control cable has been used. Miles of Rome Triplex self-supporting service cable have been installed to bring power to 36,606 new FP&L customers.

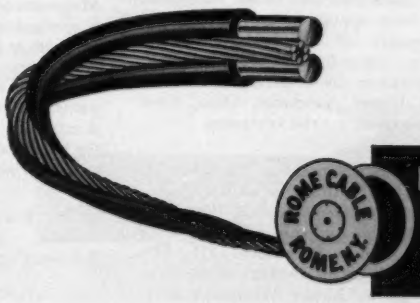
Why FP&L uses Rome Triplex—Rome Triplex secondary and service drop cable offers outstanding advantages: 1) it is neat in appearance, a distinct advantage in new home areas, 2) Triplex, with its neutral supporting messenger, is less subject to damage by storms, 3) it requires fewer accessories for secondary or service drop connections than open wire construction, 4) maintenance is less costly, and 5) conductors are more accessible, since there is no common covering.

The mechanical design of Triplex assures longer service life. Insulated with, either, RoPrene (Neoprene) or RoLene (polyethylene) compound, it has unusual resistance to sunlight, heat, moisture, corrosive atmospheres and other hazards. There are no braids to rot or festoon. Triplex comes in handy cartons, paper wrapped coils or on reels.

And RoZone-RoPrene—Every foot of Rome cable rated at 3000 volts and over is ionization level tested as a standard control procedure . . . Rome RoZone-RoPrene power cables for example. RoZone is a premium quality ozone-resistant oil-base insulation developed for long service under severe conditions. The tough RoPrene (Neoprene) sheath protects cables against abrasion and other mechanical damage. It also makes them easy to pull into conduits and ducts.

Florida Power & Light is another of many important utilities, coast to coast, which have approved Rome Cable products for installation in new plants and for expansion of vital facilities. Rome engineering can help you anticipate growing power demands for tomorrow, too.

Send today for more complete information in the Rome Power and Control Cable Catalog, and Bulletin RS-5 on Rome *copper* and *aluminum* self-supporting service drop and secondary cables.



ROME CABLE
Corporation
ROME, NEW YORK
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Give Your Product
A HEAD START
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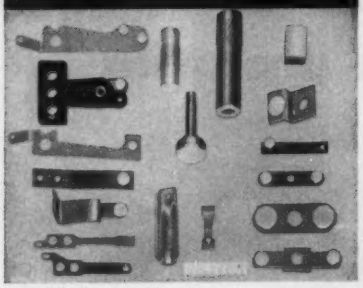
ELECTRICAL
CONTACT
ASSEMBLIES



Making complete electrical contact assemblies is a Gibson specialty that often means customers' money saved. We have the correct materials and equipment to do the job. Although we can furnish Gibson contacts of any type for assembly in your own plant, many of our customers find it economical to have us do the entire assembly job.

Engineering skill and production experience come into play. This is important because the attachment of contacts to supports is vital to total performance of your product.

Special Gibson copper alloys with high conductivity and strength are available for making contact supports—to which contacts may be welded, brazed or riveted.

Gibson contact assemblies can be made with the most economical and satifactory combination of contact form and assembly method to suit your product. Gibson-designed, Gibson-manufactured contacts and assemblies will give outstanding performance in your electrical circuit breakers, contactors, instruments, relays, rheostats, signaling equipment, switches, tap changers, thermostats, domestic appliances, and other electrical and electronic products.

For engineering data on Gibson contacts and assemblies, write for free Cat. C-520. It's yours at no obligation.

Contacts Engineered to Your Requirements

Gibsiloy
ELECTRICAL CONTACTS
Manufactured by
GIBSON ELECTRIC COMPANY
8348 Frankstown Ave., Pittsburgh 21, Pa.

INDUSTRIAL NOTES ....

General Electric News. The formation of two new organizations, an outdoor lighting department and a rectifier department, an additional step in General Electric's decentralization program, divides the former lighting and rectifier department into two separate organizations. William J. Fleming, formerly general manager of the lighting and rectifier department, has been named general manager of the new rectifier department, while L. Byron Cherry, previously manager of lighting and rectifier planning, has been appointed general manager of the outdoor lighting department.

Four men have been appointed to managerial posts in the company's advertising and sales promotion department. Ray W. Bonta was named manager of visual education; James H. Lotridge, manager of industrial advertising; William F. Stolberg, manager of media; and Richard A. Gleason, manager of agency and distributor advertising.

Roscoe S. Dick, manager of the Conneaut (Ohio) Base Works of the company's Lamp Division for the past 13 years, retired from active service, effective July 1. He is succeeded by Alfred R. Erickson, who has served as assistant manager.

Samuel Untermyer II, designer of a number of nuclear reactors and a former chief project engineer at the Argonne National Laboratory, Lemont, Ill., has joined the staff of the Atomic Power Study, Atomic Products Division.

The company will begin construction this year of a new $5,000,000 plant at Shelbyville, Ind., to manufacture industrial furnaces, induction heating equipment, and heating devices. When completed in 1955, the new plant will accommodate manufacturing operations now located at Schenectady, N. Y., and Pittsfield, Mass.

Ernest E. George, manager of design and application engineering, carboloy department in Detroit, Mich., has been named manager of magnetic products engineering.

Westinghouse Notes. O. H. Yoxsimer has been appointed manager of refrigeration engineering at the new Appliance Division plant in Columbus, Ohio. In his new position, Mr. Yoxsimer will be responsible for all phases of refrigerator-freezer engineering, both units and cabinets.

George B. Mackey has been named Pacific Coast regional manager for the Lamp Division to succeed W. H. Thompson who has been appointed assistant general sales manager of the Lamp Division.

Plans to expand its Small Motor Division operation by constructing a new plant at Upper Sandusky, Ohio, have been announced by the company.

Allis-Chalmers Promotion. Appointment of William M. Wallace as assistar manager, power department, Allis-Chalmers' General Machinery Division, has been announced. Since December 1951, Mr. Wallace had been an assistant to the vice-president of the General Machinery Division. Prior to that he was special assistant to the manager of the processing machinery department.

Honeywell Names Three Managers. Minneapolis-Honeywell Regulator Company has appointed two new branch managers and has created a district managership at Greensboro, N. C. Merritt Eusey, former head of the company's Baltimore, Md., branch, has been named to head the Pittsburgh, Pa., office, succeeding Ray Weikel who has assumed a supervisory position with the company's Industrial Division in Philadelphia, Pa. Robert S. Warnick, formerly a supervisory commercial salesman in the Philadelphia office, has succeeded Mr. Eusey as branch manager in Baltimore. Donald H. Hannasch has been appointed to the newly created position of district manager at Greensboro.

Sylvania Electric News. Sylvania Electric Products Inc. has commenced operations in the new 110,000-square-foot warehouse and sales office it has leased in Teterboro, N. J. Located at 1000 Huyler Street in Teterboro, the new facility will accommodate five railroad freight cars or eight trailer trucks in the interior loading area.

Harold D. Talbot, Jr., has been appointed advertising manager for all products, except photographic equipment, of the Lighting Division. Mr. Talbot will be located in Salem, Mass., headquarters of the Lighting Division.

Clifton H. Emerson has been promoted to the position of sales manager of national accounts, New England District, for the Sylvania Lighting Division, and Walter H. Howard has been promoted to the position of district sales manager, New England District.

RCA Changes. A separate division devoted solely to the manufacture and sales of home television receivers, and a new division for radios and "victrola" phonographs has been established, effective June 1, 1954. Henry G. Baker will serve as vice-president and general manager of the new Television Division. James M. Toney, former director of distribution, consumer products, has been appointed general manager of the newly created Radio and Victrola Division.

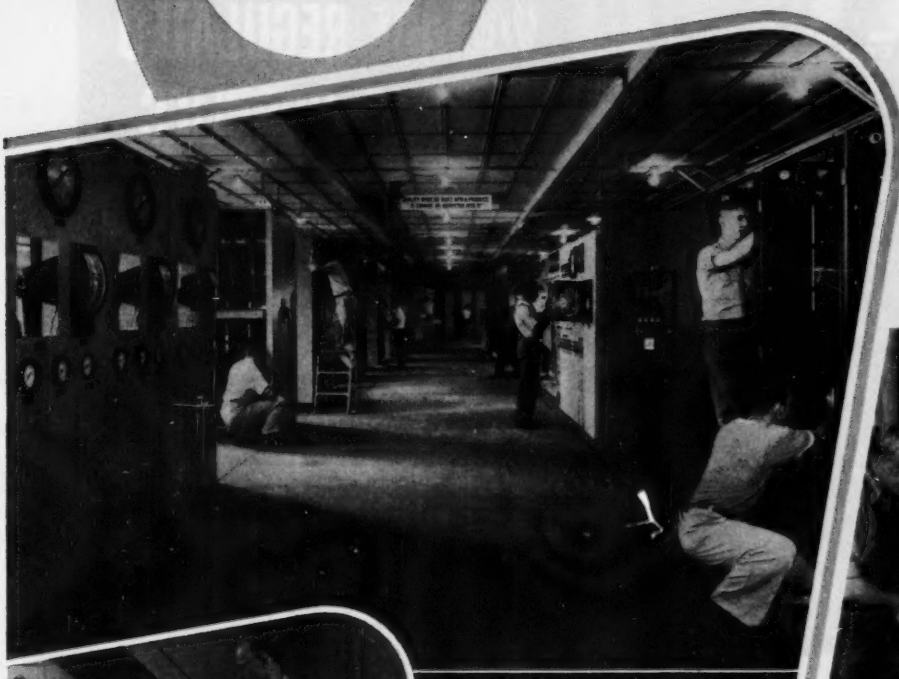
Magnecord Appointments. As part of a general reorganization and expansion program at Magnecord, Inc., Chicago, Ill., two executive appointments were announced. Erwin M. Weiss has been named chief engineer in charge of instrumentation, and Michael G. Seidl heads the technical section of the new commercial music division, as chief engineer.

U. S. Rubber Promotion. Chester J. Noonan, vice-president of United States Rubber Company, has been appointed to

(*Continued on page 24A*)

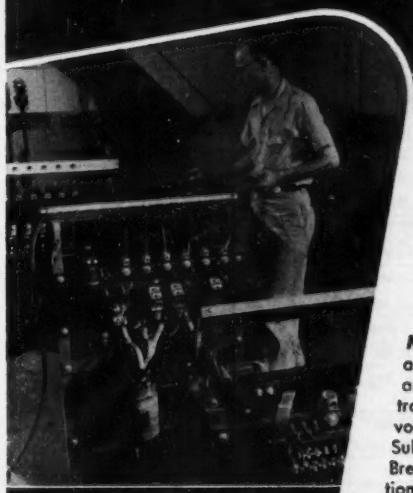
Visit OUR FACTORY!

No. 1 in a series of pictorial tours thru the Nelson Plant showing Nelson Electrical Equipment "in the making".



SWITCHBOARD ASSEMBLY BAY

In this section of our switchboard assembly bay, you see Nelson Instrument and Control Panels, Switchgear and High Voltage Motor Starters nearing completion.



OPERATIONAL TEST

Above photograph shows operational test being made on Nelson Class 431, Size 5, Reduced Voltage, Motor Starter Assembly.

WIRING MOTOR STARTERS

Here you see skilled workmen wiring a group of Nelson Class 420, Explosion-Proof, Combination Motor Starters.

MANUFACTURERS OF: Instrument and Control Panels • Benchboards and Consoles • "Centrol" Motor Control Centers • Switchgear — low voltage and high voltage • Unit Substations • Motor Starters, Circuit Breakers, Lighting Panels, Control Stations and Junction Boxes in watertight, dust-tight and explosion-proof enclosures • "Nelex" Mineral Insulated Heater Units

Write for a copy of our "Pictorial Index."

NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA

KEPCO
VOLTAGE REGULATED POWER SUPPLIES

MODEL 750

MODEL	VOLTS	CURRENT	REGULATION	RIPPLE
750	0-600	0-750 Ma.	0.5%	10 Mv.
760	0-600	0-1.5 Amp.	0.5%	10 Mv.
770	0-600	0-2.25 Amp.	0.5%	10 Mv.
780	0-600	0-3 Amp.	0.5%	10 Mv.

VOLTS	CURRENT	REGULATION	RIPPLE	6.3 V.† AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		1520
0-1200	0-20 Ma.	0.1%	10 Mv.	10 Amp.	1220
0-1000	0-500 Ma.	0.5%	20 Mv.		1350
200-1000	0-500 Ma.	0.5%	20 Mv.		1250
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	1020
0-600	0-3 Amp.	0.5%	10 Mv.		780
0-600	0-2.25 Amp.	0.5%	10 Mv.		770
0-600	0-1.5 Amp.	0.5%	10 Mv.		760
0-600	0-750 Ma.	0.5%	10 Mv.		750
0-600 0-150 Bias	0-300 Ma. 0-5 Ma.	0.5% *	10 Mv. 5 Mv.	10 Amp.	615
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	500R
#1 0-600 #2 0-600	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	10 Amp. 10 Amp.	800
0-600 0-150 Bias	0-200 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	815
#1 200-500 #2 200-500	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	6 Amp. 6 Amp.	510
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	245
0-400 0-400 0-150 Bias	0-150 Ma. 0-150 Ma. 0-5 Ma.	0.5% 0.5% *	5 Mv. 5 Mv. 5 Mv.	10 Amp. 10 Amp.	2400
0-400 0-150	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	400
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	141
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	2000
0-350	0-3 Amp.	0.5%	10 Mv.		730
0-350	0-2.25 Amp.	0.5%	10 Mv.		720
0-350	0-1.5 Amp.	0.5%	10 Mv.		710
0-350	0-750 Ma.	0.5%	10 Mv.		700
100-325 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	131
0-300 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	5 Amp.	315
0-150	0-50 Ma.	0.5%	5 Mv.		150
3-30	0-30 Amp.	0.5%	0.1%		3030
1-13	0-10 Amp.	0.5%	10 Mv.		3200

DC POWER SUPPLY SPECIFICATIONS

KEPCO Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

WORKMANSHIP

Workmanship is of a quality with the highest existing production standards and best instrument electronic practices consistent with the intended use of the item as a continuous duty voltage regulated power supply. Oil filled paper condensers and resistor-board construction are included in the design.

FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. No. 78

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KEPCO LABORATORIES

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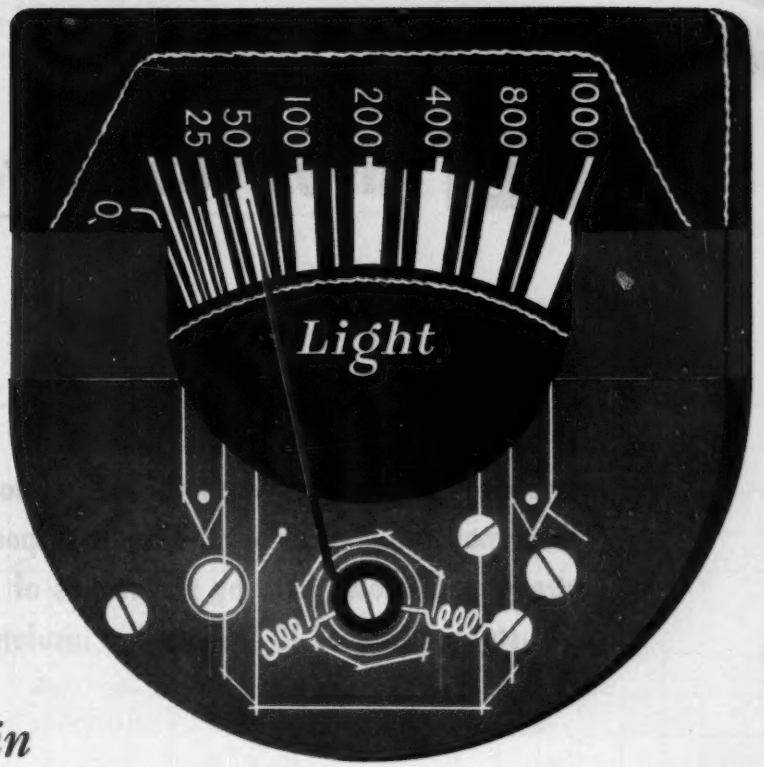


...in exposure meters too,

CRUCIBLE PERMANENT MAGNETS

afford maximum energy... minimum size

It's a fact, Crucible alnico magnets have a *consistently higher* energy product . . . which means more energy from a smaller magnet.

That's why, ever since alnico alloys were developed, Crucible has been producing them for leading manufacturers of voltmeters, watt-hour meters, exposure meters and magnet-equipped devices of all kinds.

Our twenty-years of magnet experience is backed by over a half-century of fine specialty steelmaking. You'll find that whenever you have a magnet application it will pay you to *call Crucible.*

CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **ALNICO PERMANENT MAGNETS**

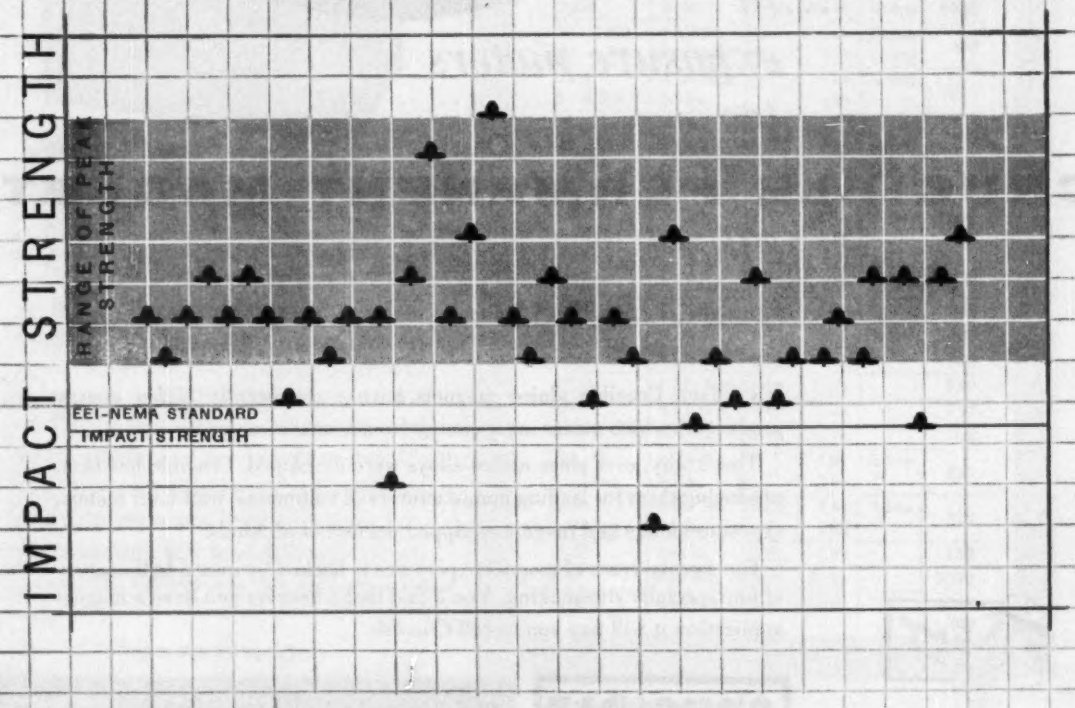
CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

Canadian Distributor — Railway & Power Engineering Corp., Ltd.

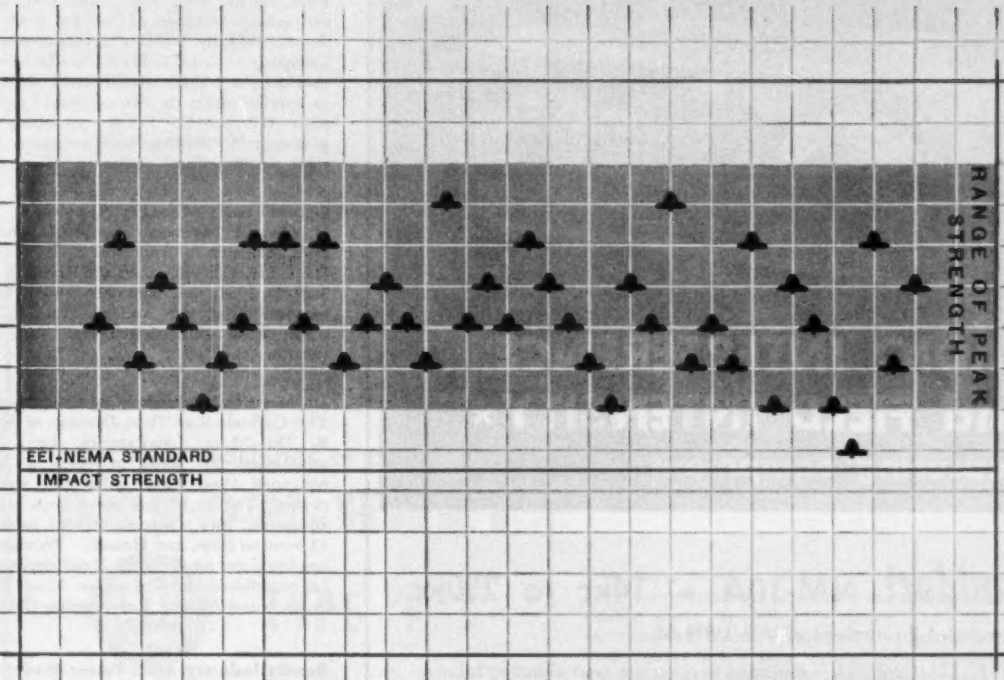
LOCKE gives you *new protection*

Impact strength of any suspension insulator now on your lines may fall well below the range of peak impact strength, as shown here by test results of representative industry samples of 10" suspension insulators.*



***FOR FURTHER DETAILS ASK YOUR LOCKE SALES REPRESENTATIVE**

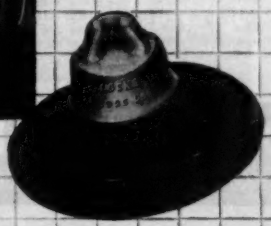
against insulator failure



AIEE standard tests reveal 98% of new 10" MICROGLAZE† Suspension Insulators fall within the range of peak impact strength.* Microscopic control of glaze thickness makes the big difference! Next time, specify MICROGLAZE Suspension Insulators...your best insurance yet against the hazards of mechanical impact.

Don't miss Locke's ½ hour color film--
"The Story of Microglaze Insulators"

LOCKE



LOCKE DEPARTMENT
GENERAL ELECTRIC COMPANY
BALTIMORE, MARYLAND

†Trademark of General Electric Company

VLF

. . . Very Low Frequencies

RADIO INTERFERENCE and FIELD INTENSITY*

measuring equipment

Stoddart NM-10A • 14kc to 250kc

Commercial Equivalent of AN/URM-6B

VERSATILITY...The NM-10A is designed to meet the most exacting laboratory standards for the precise measurements, analysis and interpretation of VLF radiated and conducted radio-frequency signals and interference. Thoroughly portable, yet rugged, the NM-10A can be supplied with accessories to fulfill every conceivable laboratory and field requirement.

EXCELLENT SENSITIVITY...The NM-10A sensitivity ranges from one microvolt-per-meter to 100 microvolts-per-meter, depending upon whether rod or shielded loop antennas or line probe are used.

ACCURACY...Each equipment is "hand calibrated" in the Stoddart Test Laboratories by competent engineers. This data is presented in simplified chart form.

DRIPPROOF...Sturdy dripproof construction allows long periods of operation in driving rain or snow without adverse effects.

FLEXIBLE POWER REQUIREMENTS...The ac power supply permits operation from either 105 to 125 volts or 210 to 250 volts ac, at any frequency between 50 cps and 1600 cps.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

HF NM-20B, 150kc to 25mc
Commercial Equivalent of AN/PRM-1A. Self-contained batteries. A.C. supply optional. Includes standard broadcast band, radio range, WWV, and communications frequencies. Has BFO.

VHF
NM-30A, 20mc to 400mc
Commercial Equivalent of AN/URM-47. Frequency range includes FM and TV bands.

UHF
NM-50A, 375mc to 1000mc
Commercial Equivalent of AN/URM-17. Frequency range includes Citizens band and UHF color TV band.

STODDART AIRCRAFT RADIO Co., Inc.

6644-B Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

(Continued from page 18A)

the newly created position of executive general manager of two operating divisions of the company. In his new position, Mr. Noonan will be responsible for the operations of the company's second and third largest divisions, the Footwear and General Products Division, and the Mechanical Goods Division.

I-T-E Acquires BullDog Electric. W. M. Scott, Jr., president of the I-T-E Circuit Breaker Company, with main offices in Philadelphia, Pa., has announced that through an exchange of common stock on June 1, 1954, the BullDog Electric Products Company of Detroit, Mich., has become a subsidiary of I-T-E. BullDog will continue to operate under its own corporate name, with William H. Frank remaining as president of BullDog and retaining the same personnel and policies.

General Sales Manager Appointed. R. D. Cleaves has been appointed general sales manager of Anderson Brass Works, Inc. Mr. Cleaves joined the company on July 1, 1954, and assumed general sales responsibilities for Anderson in utility, transmission and distribution, and distributor fields.

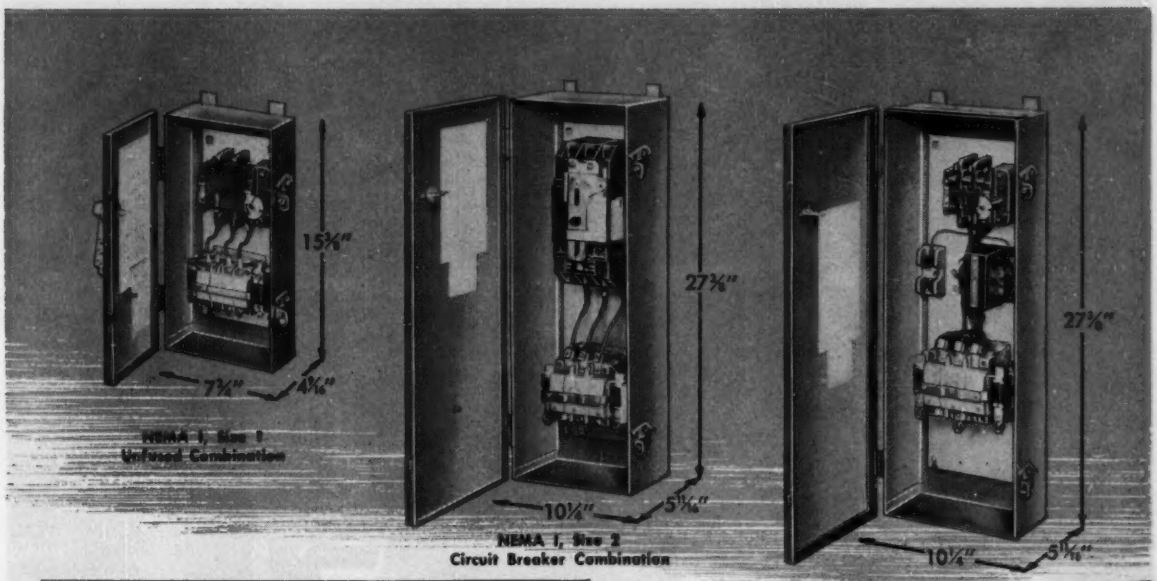
Du Mont to Establish West Coast Depot. The Cathode-Ray Tube Division of Allen B. Du Mont Laboratories, Inc., has announced its plans to open a fully equipped West Coast sales and service depot. The depot will serve both initial equipment and replacement tube users in 11 western states and Hawaii. Permanent headquarters for the West Coast depot will be established on September 1, at 2545 South Yates Avenue, Los Angeles, Calif.

Bendix Industry Atom-Power Study. A research program on new applications of atomic power to nonmilitary projects will be undertaken by the Bendix Aviation Corporation as a result of a study agreement with the Atomic Energy Commission (AEC). Results of the year's program to be undertaken by the corporation's nuclear engineering staff will be summed up in a report of its findings to the Commission. The study agreement conforms with the AEC policy of encouraging industrial developments of nonmilitary applications of atomic energy. The report will make recommendations concerning the role of private industries in the atomic energy field. It also is expected that new reactor designs and certain uses for radioactive isotopes or fission products may evolve from the research.

NEW PRODUCTS • •

Dielectric Coating. A resilient coating or encapsulating material for extreme-temperature electric and electronic components has been developed by Dow Corning Corporation. Identified as Silastic *S-2007*,

(Continued on page 28A)



New PERFORMANCE STANDARDS

for new machines or old with

ARROW-HART

TYPE "RAC"

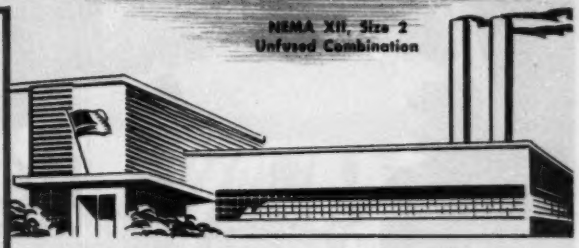
COMBINATION STARTERS

ENCLOSURES:

- GENERAL PURPOSE (NEMA TYPE I)
- INDUSTRIAL USE (NEMA TYPE XII) . . . built to JIC STANDARDS
- Also for Textile and Other Industrial Applications

AVAILABLE:

- WITH DISCONNECT . . . Fused or Unfused
- WITH CIRCUIT BREAKER TYPE DISCONNECT
- IN ACROSS-THE-LINE, REVERSING and TWO-SPEED TYPES
- IN NEMA SIZES 0, 1, and 2
- WITH AND WITHOUT CONTROL CIRCUIT TRANSFORMER, LOCAL CONTROL, AND OTHER MODIFICATIONS



Combining radically smaller size and lighter weight with the advantages of advanced safety and dependability, these revolutionary Arrow-Hart Type "RAC" Combination Starters outwork . . . outlast . . . outmode every other type. An all-new, front-operated disconnect—a new line of enclosures in NEMA Types I and XII — and the exclusive A-H "Right Angle" Starter set new standards for maintenance ease, superior performance, and control versatility.

YES! Arrow-Hart Type "RAC" Combination Starters will help all machines—*old and new*—realize their full productive efficiency. Extreme dependability helps eliminate costly down-time . . . smaller size, easily accessible contacts, and extra room in the enclosure provide the ultimate in installation and maintenance ease . . . Straight-Thru wiring improves safety standards.

You owe it to yourself to write for complete information — NOW!

MAIL THIS COUPON TODAY

SINCE 1890

ARROW • HART

INDUSTRIAL CONTROL DIVISION

103 HAWTHORN ST., HARTFORD 6, CONN., U.S.A.

Offices, sales engineers and warehouses in: Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Indianapolis, Los Angeles, Milwaukee, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco. In Canada: Arrow-Hart & Hegeman (Canada) Ltd., Mt. Dennis, Toronto. In England: Arrow Electric Switches, Ltd., Ealing, London W5.

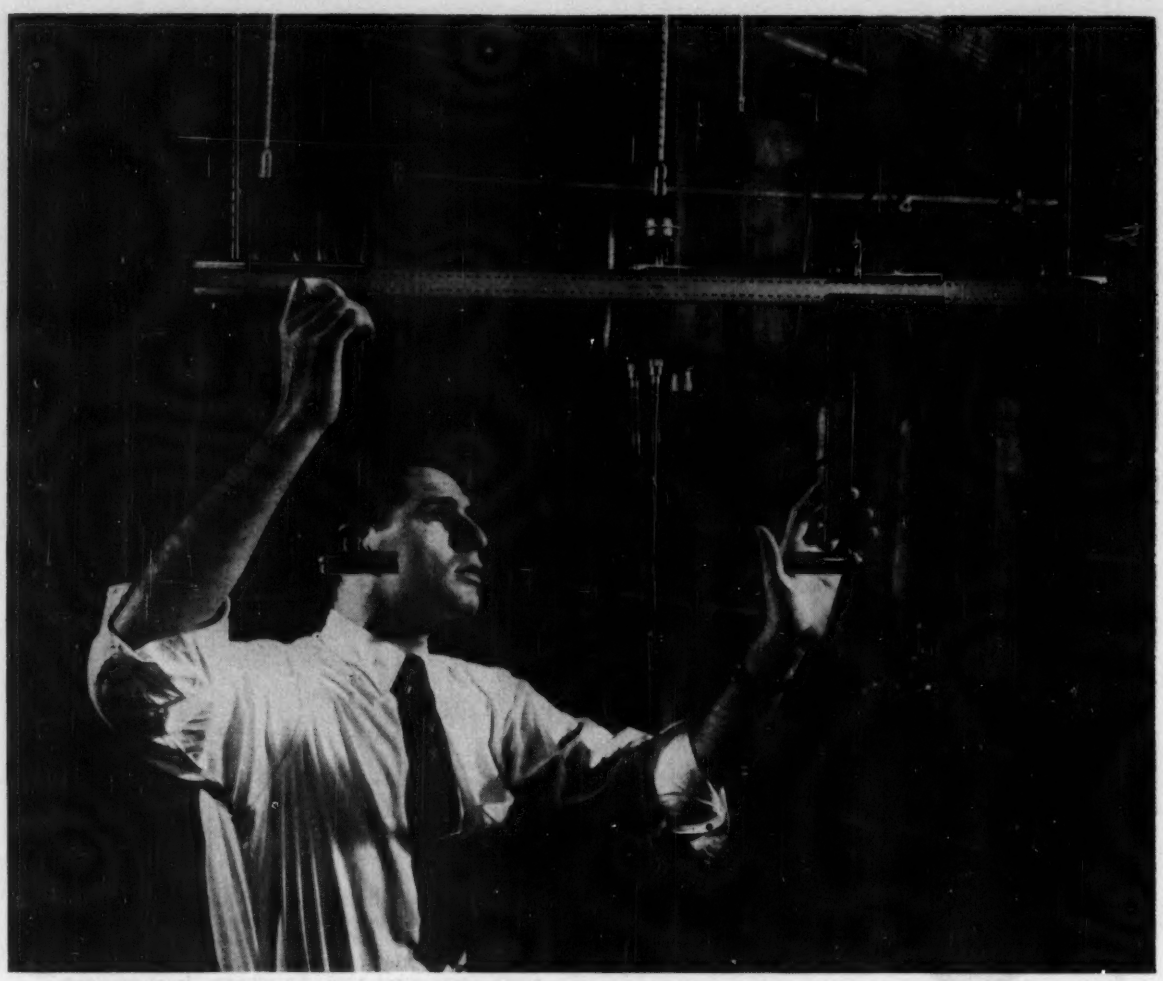
Quality MOTOR CONTROLS • WIRING DEVICES
ENCLOSED SWITCHES • APPLIANCE SWITCHES

INDUSTRIAL CONTROL DIVISION
THE ARROW-HART & HEGEMAN ELECTRIC CO.
103 HAWTHORN STREET, HARTFORD 6, CONN.

☐ *Please send literature describing the Type "RAC" Combination Starter.*
☐ *Please send catalog covering the complete AH-Motor Control Line.*

NAME _____
POSITION _____
COMPANY _____
COMPANY ADDRESS _____
CITY _____ ZONE _____ STATE _____

EE



In a quiet room at Bell Laboratories an engineer scales off the distance between two condenser microphones during a calibrating test. Able to measure air pressure variations of a few billionths of an atmosphere, such microphones play a crucial role in the scientific study of telephone instruments.

SOUND STEPS ON THE SCALES

Those small cylinders facing each other are condenser microphones—measuring tools that play a vital part in making your telephone easier to hear and talk through.

They are being calibrated by an engineer at Bell Telephone Laboratories to give extremely accurate information on the kind of sound your telephone company handles. Armed with these vital fundamental data on what sound *is*, Bell Laboratories scientists devise the instruments and equipment that transmit it best.

At Western Electric, manufacturing unit of the Bell System, a condenser microphone "listens" as your ear would listen to every telephone before it goes into service. The condenser microphone is but one of many precise tools that Laboratories scientists have developed to make telephone service better and more economical.

BELL TELEPHONE LABORATORIES

Improving America's telephone service offers careers for creative men in scientific and technical fields.

Maintenance Costs Go Down

with NATIONAL CARBON BRUSHES for

TRADE-MARK

MAIN DRIVE, MILL-TYPE AND GENERAL-PURPOSE MOTORS

ENGINEERS:
Fewer items do a better job when you select "National" brushes—simple, fast, accurate brush specification for *you!*

MAINTENANCE MEN:
Long life, low friction, minimum commutator maintenance — an outstanding cost-record for *you!*

PURCHASING AGENTS:
The brushes you want, *when* you want them, from stock or catalog listings — you get a higher degree of in-plant-standardization, lower inventory, fewer costly, short-run items!

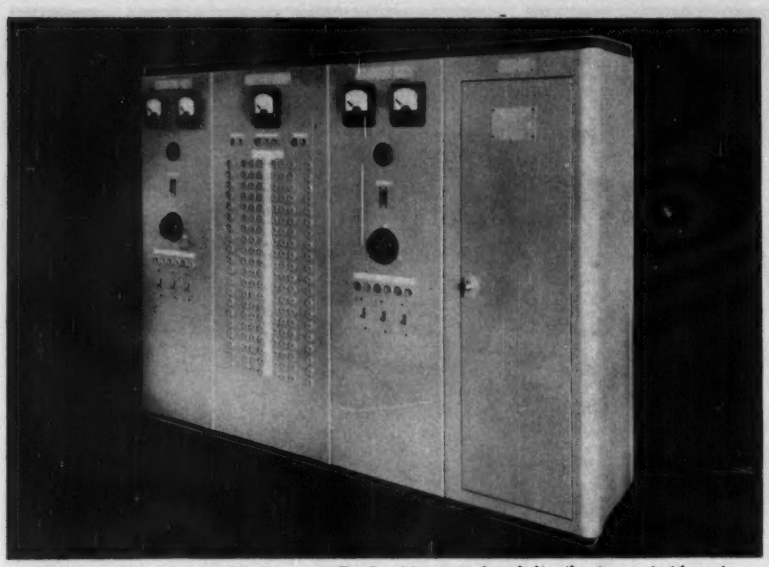
STOREKEEPERS:
Stack 'em high, wide and handsome with these durable, easy-to-identify "National" brush cartons — good housekeeping, faster check-outs for *your* department!

How good is really good brush performance? Use "National" brushes and see!

The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
IN CANADA: Union Carbide Canada Limited, Toronto

NATIONAL STANDARDIZED BRUSHES
BETTER— PRODUCT—PACKAGE—PIECE— FASTER



At Howard University, Washington, D. C., this control and distribution switchboard is supplied with pure, non-fluctuating D-C current by a Nicad Battery.

Where Pure D-C is vital

. . . that's a job for Nicad

For installations where neither a D-C generator or rectified A-C is adequate, a Nicad Battery is the logical answer.

Besides providing the necessary stability of voltage required in all types of laboratories, this modern power source has many other advantages.

The Nicad Battery requires no specially ventilated battery room and needs only a minimum of attention. It can be charged at normal or high rates, trickle charged or floated, and may be left standing in any state of charge without harm. It does not give off noxious or corrosive fumes. Rugged steel construction and freedom from self-deterioration assure extra long, extra economical service life.

It will pay you to learn more about these and other important reasons why it is being chosen for many *vital services* — for which its counterpart, the nickel cadmium battery has long been standard equipment in Europe. Data available.

NICAD

The Battery with the Steel Constitution

Use coupon to obtain Nicad information

NICKEL CADMIUM BATTERY CORPORATION 40112
Box 511, Easthampton, Mass.

Please send further data on the Nicad Battery. Our special fields of interest are (please check)

☐ Laboratory ☐ Switchgear Operation ☐ Emergency Light and Power ☐ Stationary Engine Starting ☐ Telephone Service ☐ Communications ☐ Signal Operation ☐ Marine Standby

Name.....

Function.....

Company.....

No. and St.....

City.....Zone....State.....

(*Continued from page 24A*)

the new silicone rubber cures in 2 to 4 hours at 200 C to form a rubberlike jacket which is uniform, heat-stable, moisture-proof, and highly resistant to oxidation, ozone, and weathering. Supplied as a solvent-free low-consistency paste, it may be applied by dipping, vacuum impregnating, or may be placed directly into a hot oven for vulcanization. Neither pressure nor a graduated cure is necessary.

Twin Connector. Ilsco Tube and Products, Inc., Cincinnati, Ohio, has begun production of a new rugged, never-failing twin connector *MU*. The new connector is compact, low in height, and as narrow as two maximum conductors. It is designed to replace a larger single connector. *MU* accommodates two wires and is available in three sizes: *MU 250* for 250 MCM-6 wire range, *MU 350* for 350-4 wire range, and *MU 600* for 600 MCM to 4/0 wire range. Samples, prices, and details may be obtained by writing Ilsco Copper Tube and Products, Inc., Mariemont Avenue, Cincinnati 27, Ohio.

Compression Tool. Designed to fill the need for a lightweight hand tool to install ordnance-type Hysealug compression terminations on number *12* and number *14* rubber-insulated wire, and also close the insulation grip, Burndy Hytool type *MR8-23* is ratchet-controlled, to insure correct depth of indent and single-stroke operation. The tool is of aluminum-alloy construction and has one indentor that accommodates both cable sizes and two grooves to close the insulation grip, providing a watertight seal. Pocket-size compactness, small handle span, and high-mechanical-advantage toggle-action jaws permit 1-hand fatigue-free operation. For more information on the Hytool and Hysealugs, write to Burndy Engineering Company, Inc., Norwalk, Conn.

Magnecord Reproducer. A high-fidelity magnetic-tape music reproducer that will automatically play 8 hours of prerecorded music, continuously or intermittently from a single reel, has been announced by Magnecord, Inc. The basic unit consists of a continuous tape reproducer and a 10-watt high-fidelity power amplifier. Additional optional equipment includes a high-fidelity speaker system, and an automatic program master.

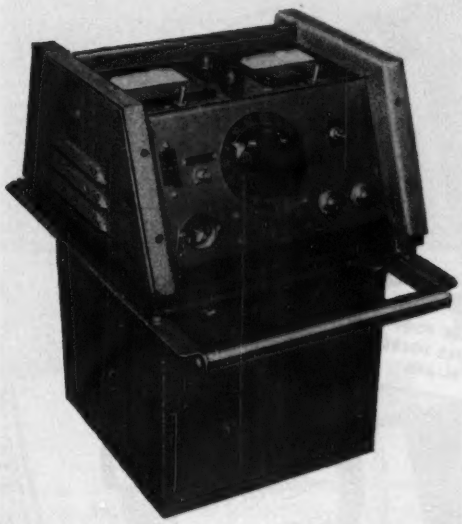
Flexless Side-Break Switch. A completely redesigned, type *A-6* side-break air switch has been announced by the R&IE Equipment Division of I-T-E Circuit Breaker Company, Greensburg, Pa. A sealed pressure hinge contact has replaced the flex connection at the swivel hinge which is a vital point on 2-insulator switches. The same sealed pressure hinge contact is used on the new swivel high-pressure contact jaw. The new type *A-6* is built in voltages from 7,500 through 115,000, with current ratings from 400 through 1,200 amperes.

(*Continued on page 38A*)

BIDDLE *Instrument News*

NEW PRODUCTS

New Biddle Dielectric Test Set Model 1-40 KV



—for measuring d-c current at voltages up to 40 kv when applied to the insulation of such equipment as generators, transformers, bushings and cable.

This portable field instrument has been developed in response to the growing use of and demand for higher d-c test voltages.

Carefully considered safety features, excellent output voltage regulation, simple operation, compact design, and facilities for making voltage and current measurements at either polarity have been incorporated in this test set. Years of Biddle engineering experience in insulation testing are reflected in this equipment which has already proven its reliability and performance in field use.

The set has a current rating of 25 milliamperes at short circuit, and current measurements can be made down to 0.5 microamperes which is the first division on the microammeter.

Overall dimensions are: height 19½ in., width 13½ in., depth 20 in., weight 120 lbs. All high voltage components are oil immersed.

For complete details, description, specifications, and prices, write for **Bulletin 22-EE.**

Showing The Biddle Dielectric Test Set, Model 1, on a special hand truck supplied as an accessory for this equipment. This truck permits one man to handle the set safely and without difficulty, on stairways as readily as on the straightaway.

Biddle Motor Rotation and Phase Tester (*Dual Purpose*)

With it you can . . .

- **Determine the direction of rotation of electric motors before they are connected to the line.**
- **Determine the phase rotation or sequence of energized power circuits.**

Here is a positive means for determining which motor leads must be connected to certain conductors of a supply system to insure that the motor will rotate in a prescribed direction when energized.

This device will permit the electrical contractor or industrial maintenance electrician to permanently connect and tape the terminals of the motor being installed, without having to first energize the motor by a temporary "hook-up" from a power source, if available, to determine its rotation.

Housed in a sturdy oak case 12¼" x 8¼" x 4¼" this compact unit weighs approximately 10 pounds and is supplied complete with 3 line and 3 motor leads which store in the compartments either side of the instrument panel.

For complete details write for **Bulletin 80-EE.**

B-418

JAMES G. BIDDLE CO.

1316 ARCH STREET • PHILADELPHIA 7, PA.

ELECTRICAL TESTING INSTRUMENTS • SPEED MEASURING INSTRUMENTS • LABORATORY & SCIENTIFIC EQUIPMENT

For easier application...

New Quinterra® and Quinorgo® Composites provide high mechanical strength

Samples of these Johns-Manville purified asbestos electrical insulations now available for testing by manufacturers and motor repair shops

Quinterra Type 3-GR is a Class H electrical insulation, good for operating temperatures up to 250C. It is constructed of a silicone-saturated purified asbestos sheet with a backing of smooth, tightly woven glass cloth. Type 3-GR combines exceptional tensile and tear strength with the highest humidity and pyrolysis resistance of any asbestos type insulation.

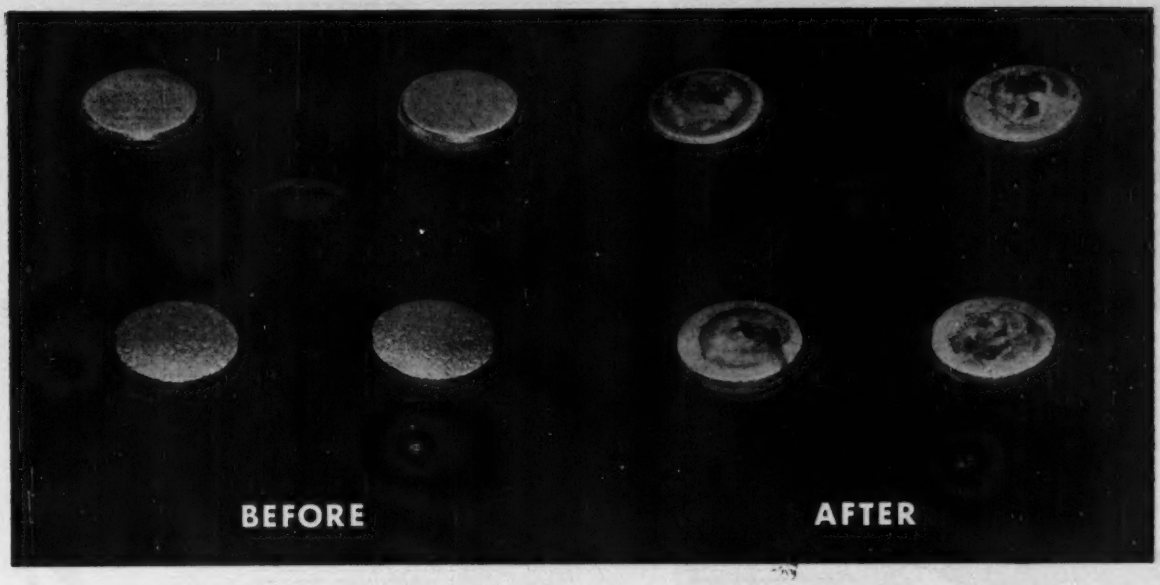
Quinterra Type 5-GR and Type 5-GL are premium quality Class B purified asbestos electrical insulations treated to resist operating temperatures up to 150C. Both have exceptional tensile and tear strength, with lasting dielectric strength. Type 5-GR (duplex) is one sheet of Type 5 bonded to one sheet of glass cloth, Type 5-GL (triplex) is one sheet of glass cloth between two sheets of Type 5.

Quinorgo No. 4000-GR and No. 4000-GL are economical Class B purified asbestos electrical insulations with exceptional tensile and tear strength and thermal stability. No. 4000-GR (duplex) is glass cloth backed with Quinorgo 4000. No. 4000-GL (triplex) is one sheet of glass cloth between two sheets of Quinorgo 4000. Both are untreated and readily absorb commercial insulating varnishes.

SAMPLES OFFERED WITHOUT CHARGE

These sample folders with description of the electrical and physical properties of Quinterra and Quinorgo composites are available from your insulation distributor. Or write Johns-Manville on your company letterhead indicating which type or types you desire. Address Johns-Manville, Box 60, New York 16, N. Y.; In Canada, 199 Bay St., Toronto 1, Ontario.

Johns-Manville ELECTRICAL INSULATIONS



PROOF OF LOW MAINTENANCE ON CLARK TYPE "CY" STARTERS

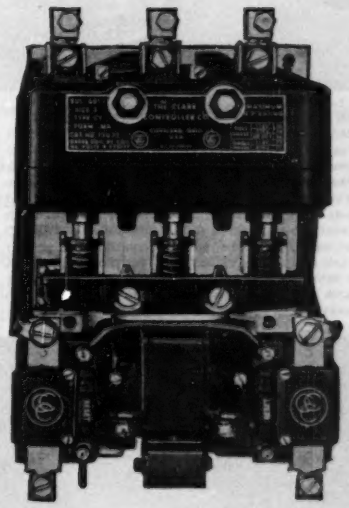
These unretouched photos show contact tips from a CLARK Bulletin 7707 contactor—the contactor used in the standard Bulletin 6013 size 2 AC Motor Starter—as they looked before and after a year of hard use.

The contactor is in service at Cleveland Hone and Manufacturing Company, on a special transformer and rectifier circuit used in processing automotive parts. The tips shown right above were removed from the contactor after 12 months of steady service, often operating as frequently as 5000 times per hour.

Note that slight discoloration and minute pitting are the only evidence of wear. They require no cleaning, dressing or filing, and are in condition to give many more years of dependable service.

The secret of long contact life in the CLARK Type "CY" Starter is its exclusive arc-quenching principle, using strong multi-turn magnetic blowouts and double-break contacts. Forced rotation causes the arc to move continually on the contact surfaces, distributing the heat and preventing pitting or "build-up" at any one point. Result: extremely effective arc interruption, and greatly reduced wear on tips.

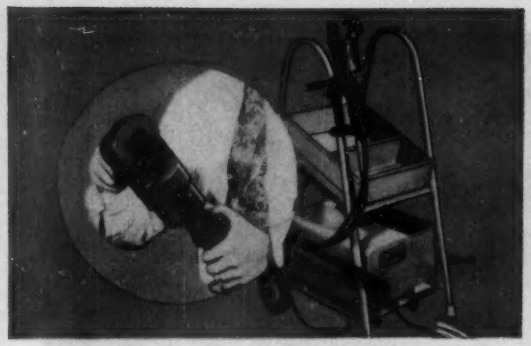
Write for descriptive literature.



CLARK Type "CY" Starters include many more features for dependable service and reduced maintenance. Let us tell you the complete story.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO



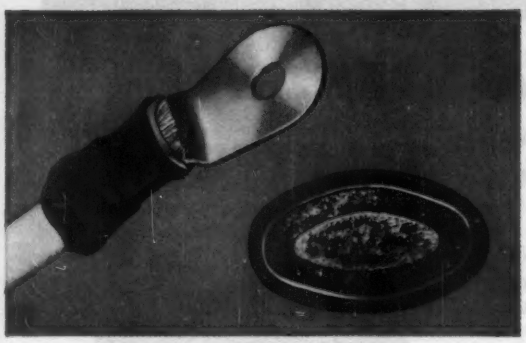
NEW DYNA-CRIMP TOOL
New, powerful, DYNA-CRIMP tool features fast positive crimping action and easily-opened swivel head. Crimping heads can be changed easily. A-MP DYNA-CRIMP tool gives maximum portability with remote control operation. Interchangeable dies are available for use with A-MP's complete line of Aluminum and Flag terminals. Shown above with moveable cart to transport power unit providing maximum flexibility for Bench-Production line use.

AMP

FIRST IN SWITCHGEAR!

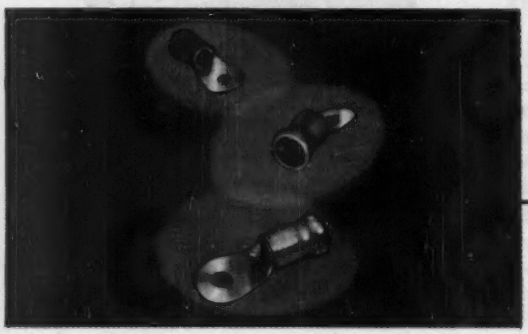
SIZES 8 THROUGH 4/0

Ampli- Trade-Mark



BONDING FEATURE MOST IMPORTANT
Bonded insulation is the most important factor *in producing a successful insulated terminal.* The positive and complete bond of the insulation to the terminal sleeve insures uniform insulation thickness under crimping pressures, and therefore transmits this pressure evenly to the center of the crimp area. With this precision-engineered A-MP crimp and BONDED insulation you can be sure of maintaining proper dielectric and tensile values in the finished connection. More intimate contact achieved by confining, over a greater area, terminal and wire under intense crimping pressure.

WITH INSULATION SUPPORT AND SUPERIOR A-MP CONFINED CRIMP.

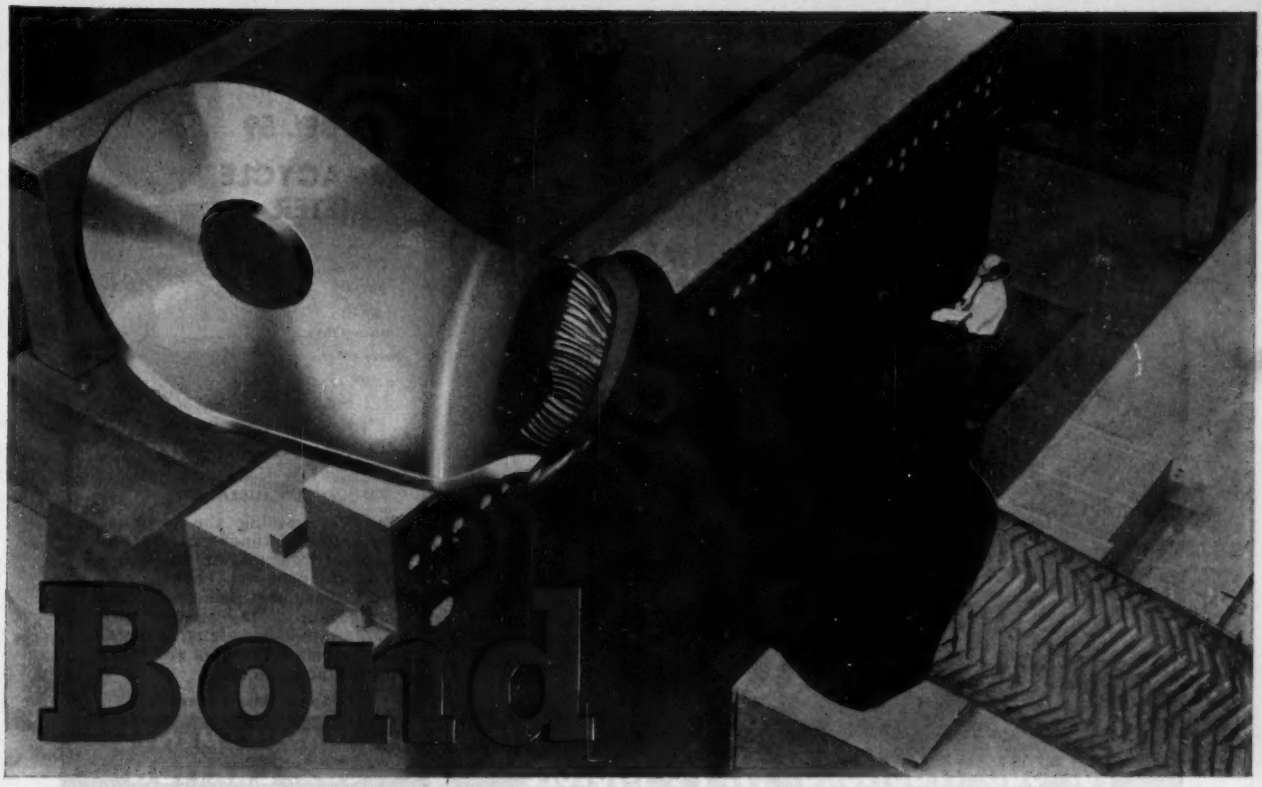


OTHER IMPORTANT A-MP "FIRSTS"
Completely separate metallic reinforcing ring grips wire insulation, prevents exposure of conductor during sharp bends, cable fatigue caused by flexing and vibration and forms a barrier to foreign objects coming in contact with current carrying members. New helical tongue design gives maximum strength with minimum weight.

AMP Trade-Mark Reg. U.S. Pat. Off. © AMP

Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

...An evaluation survey without cost or obligation.



THE ONLY LARGE SIZE TERMINAL WITH BONDED INSULATION!

10 distinctive and distinguishable features make precision-engineered AMPLI-BOND terminals the best quality insulated termination for copper wire.

- INSULATION WITHSTANDS A MINIMUM OF 6000 VOLTS!
- INNER COPPER SLEEVE FOR STRENGTH AND VIBRATION RESISTANCE
- FULLY INSULATED METALLIC REINFORCING RING GRIPS INSULATION
- COLOR CODED FOR RAPID IDENTIFICATION
- SUPERIOR A-MP CONFINED CRIMP
- BRAZED BARREL SEAM
- INNER BARREL DIMPLED FOR INCREASED TENSILE STRENGTH
- COPPER TERMINAL BODY ELECTRO-TINNED FOR HIGH CONDUCTIVITY
- BONDED INSULATION
- PROOFMARK FOR POSITIVE IDENTIFICATION

Here is a large size terminal that presents to the users of heavy duty wire the same quality connection that has made A-MP famous for PRE-INSULATED type terminals throughout the industry. Write today for information about AMPLI-BOND and new powerful AMP DYNA-CRIMP portable pneumatic-hydraulic crimping tool.

AIRCRAFT-MARINE PRODUCTS, INC.

2100 Paxton Street Harrisburg, Pa.

In Canada—AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD.
1764 Avenue Rd., Toronto 12, Ont.

AMP

MIGHTY MITE BUILT IN PROTECTION

for sub-fractional H. P. Motors

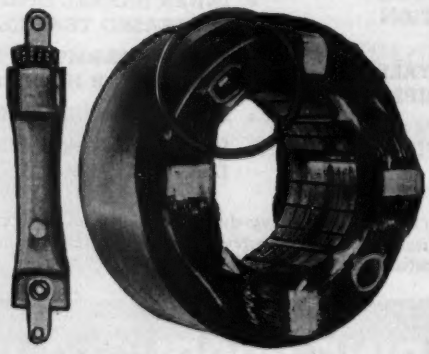
MIGHTY MITE pre-set thermostats will fit into the present design of your stator windings without necessitating any appreciable change in your assembly line procedure.

Install MIGHTY MITE miniature thermostats in your sub-fractional HP motors for continuous automatic protection against charring of insulation, burn-out and fire damage.

Samples, catalog or engineering aid available on letterhead request.

MIGHTY MITES:

- Fit most present designs
- Feature sturdy uniform construction
- Are accurately pre-set
- Can be furnished with various types of terminal connections
- Are ready for immediate use



MIGHTY MITE thermostats also protect lighting and control transformers, heating coils, generators, signal devices, air conditioning units, window ventilating fans, rectifiers, etc.

MIGHTY MITE THERMAL PROTECTORS

MECHANICAL INDUSTRIES PRODUCTION COMPANY

217 ASH STREET • AKRON, OHIO

Measurements Corporation

MODEL 59 MEGACYCLE METER

The only grid-dip meter covering the wide range of **2.2 Mc. to 400 Mc.**

FREQUENCY CALIBRATION: ±2%

For determining the resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, etc. For measuring inductance and capacitance. May also be used as an auxiliary signal generator; for signal tracing and many other applications.

Complete data on request.

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. . . FOR EVERY REQUIREMENT IN THE ELECTRICAL FIELD

Our Record: Over 50 years of progressive galvanizing service to manufacturers and fabricators of iron and steel products . . . any size or shape, any size order from the smallest to the largest. *Excellent facilities for pickling and oiling.*

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LET THIS STREET LIGHT STANDARD "SWEAT"!

ITS WIRES ARE COVERED WITH BAKELITE POLYETHYLENE
TRADE-MARK

Installation of 5000 volt No. 8 street lighting wire on Main Street, Buffalo, N. Y., by Niagara Mohawk Power Corp.

No condensation worries here . . . moisture *can't* get at the conductors! BAKELITE Polyethylene is virtually non-absorbent. Its insulation resistance stays constant even during extended periods of immersion in water.

In addition, this outstanding material is resistant to aging—won't harden and crack. Tests with the black compound indicate a service life of several decades.

BAKELITE Polyethylene meets or exceeds every requirement in Appendix "P" of the new IPCEA specifications for polyethylene. It stays tough and flexible at —70 deg. C. Its lightness and smoothness make stripping and pulling easier. Its excellent dielectric properties mean smaller wire diameters, smaller ducts, easier handling.

These advantages combined with low cost can bring real economy to your operations. Ask your cable supplier for complete information on wire and cable covered with BAKELITE Polyethylene, or write Dept. XS-66.

BAKELITE
TRADE-MARK
Polyethylene
FOR WIRE COVERING

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

1951 GENERAL ELECTRIC INTRODUCES SELF-X, A NEW FLAME-RETARDANT INSULATION

1954 SELF-X GUARDS OVER 10,000 GENERAL ELECTRIC METAL-CLAD UNITS

G-E METAL-CLAD SWITCHGEAR lineup features Self-X, G.E.'s service-proved flame-retardant insulation, at vital points.

COFFIN AWARD. Nicholas F. Arone, laboratory engineer in G-E Switchgear Product Laboratory, receives Company's highest employee honor—the coveted Coffin Award—from G. E. Burens, General Manager, Switchgear and Control Division, for developing Self-X insulation.

COMPARISON TEST shows why Self-X insulation gives better protection to metal-clad switchgear. In this photograph, taken immediately after both pieces of insulation were withdrawn from the flame, N. F. Arone (at right) holds a piece of ordinary insulation which continues to burn, while the Self-X held by H. F. Hentschel, General Manager—Medium Voltage Switchgear Department, stopped burning as soon as flame was removed. Other tests of Self-X included exposure to electric arc.

Self-X insulation proved by three years of service

Back in 1951, the first sheets of a new type of flame-retardant, self-extinguishing insulation, just developed by General Electric, were installed in a metal-clad switchgear unit.

In severe laboratory tests, the new Self-X insulation proved that it could stand up even under direct flame or an electric arc. As soon as direct flame contact was removed, polyvinylchlorides in the laminated sheets went to work *fast*. Smothering action started—and the fire was put out in less than a minute.

That was over three years ago. Today, this service-tested insulation developed by General Electric Company is acting as a built-in fire extinguisher for over 10,000 switchgear units. Its flame-retardant features make it ideal for bus and cable supports, insulating barriers, between compartments, box carriers for arc chutes—all vital spots.

Self-extinguishing insulation is just one of the advanced safety features of G-E Metal-Clad Switchgear, which helps guard utility and industrial power distribution systems. To learn more about it, call your nearest G-E Apparatus Sales Office or Authorized Agent. Or write for bulletin GEA-5664 to General Electric Company, Schenectady 5, N.Y.

511-4

Progress is our most important product

GENERAL ELECTRIC

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MODEL M-2
Low Distortion

R-C OSCILLATOR

Unexcelled for:

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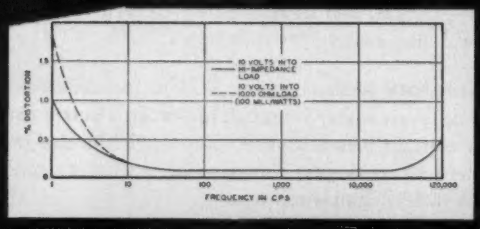
- ★ Galvanometer manufacture
- ★ Vibration Analysis
- ★ Variable frequency standard
- ★ Transformer & servo design



Guaranteed
SPECIFICATIONS:

Wide frequency range
1 to 120,000 cycles per second

Accurate dial calibration
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Fully regulated power supply
ripple less than .01% of output

Low frequency drift
less than 1% over long term

Excellent amplitude stability
[illegible] db throughout range

High output **425.00**
20 volts into 1000 ohms or more
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1 volt at 300 ohms constant impedance

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(*Continued from page 28A*)

RCA New Test Instruments. Four new electronic test instruments for the alignment adjustment, and servicing of home color television receivers were placed on the market by the Tube Division, Radio Corporation of America. They also have applications in the design and production-line testing of color receivers.

Circuit Breakers. Available now is a new line of type *AB* molded-case circuit breakers produced by the Federal Electric Products Company. Designed primarily for circuit protection in industrial plants and commercial buildings, type *AB* circuit breakers operate on a thermal-magnetic principle that will pass temporary light overloads, but will trip instantaneously on heavy faults. Ratings range from 15 to 600 amperes, 600 volts maximum. For further information write to the Hartford Division, Federal Electric Products Company, 1429 Park Street, Hartford, Conn.

Underwriter-Approved Motor Line. Extension of Allis-Chalmers underwriter-approved line has been announced with the approval by Underwriters' Laboratories, Inc., Chicago, Ill., of a 1,250-hp 2,300-volt 1,780-rpm Allis-Chalmers explosion-proof motor (type *ANZZ*). This represents the largest machine of its kind approved by the Laboratories to date.

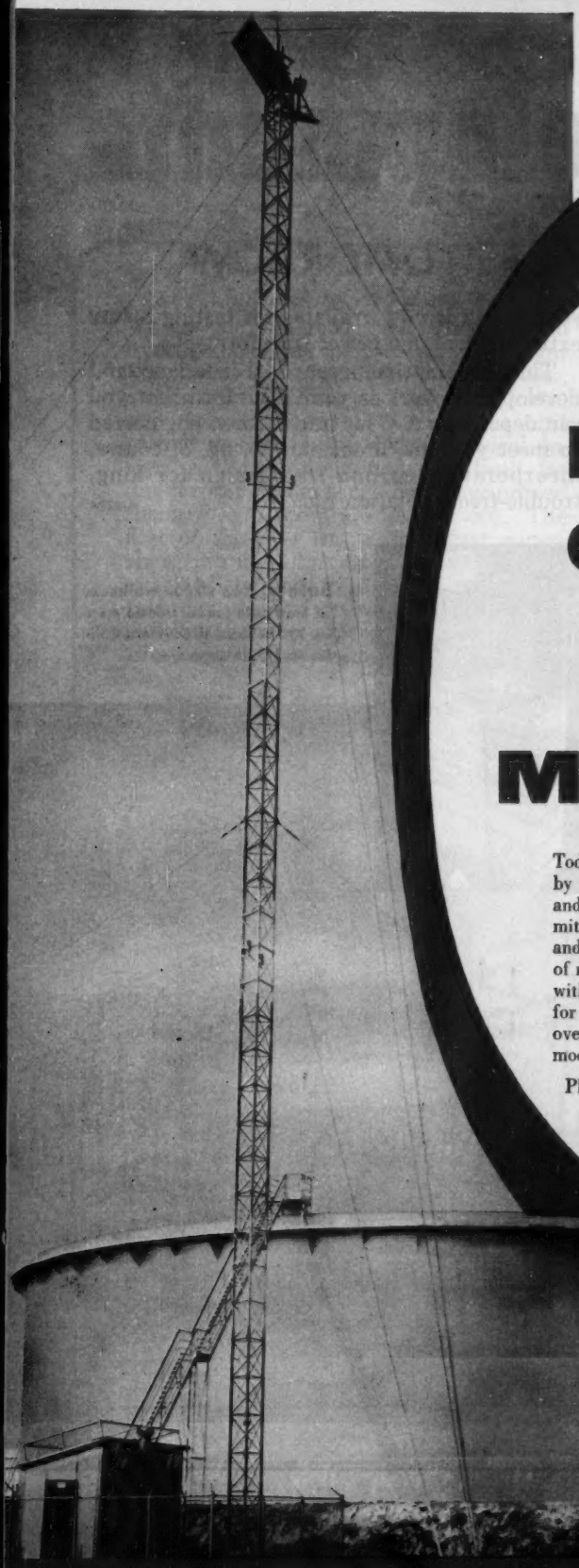
G-E Weathertron. The new G-E Weathertron, designed for larger homes and commercial buildings, is powered by two modulated 5-hp compressors and will handle up to 3,000 cubic feet of air per minute. It features a completely sealed hermetic refrigeration system warranted for 5 years. The new Weathertron, designated the *98B*, will supplement the department's present line of 3- and 5-hp models.

Kollsman Magnetic Recording Systems. Kollsman Instrument Corporation has entered a new field with the manufacture of their first magnetic recording systems. Present Kollsman models have a medium storage capacity of 60,000 impulses or binary digits on their magnetic-oxide-coated drums. The recording heads in the Kollsman systems are designed to record and reproduce frequencies up to 1 mc.

High-Voltage Switch. A recently developed vacuum switch is externally operated by a d-c solenoid and it is ideally suited for switching purposes in d-c pulse systems, especially in radar installations. It can be used in many circuits where the switching current and the isolation of high voltage is required. This high-voltage high-vacuum switch, part number *NVS-300*, is normally closed single-pole double-throw high-voltage device. For further information write to Richard R. Blayney, NAER Corporation, 2301 South Purdue Avenue, West Los Angeles 64, Calif.

Hermetically Sealed Pulse Transformer. Berkshire Labtrans hermetically sealed

(*Continued on page 42A*)



Complete PIPE LINE CONTROL with PHILCO MICROWAVE

Today, 1000-mile-plus pipe line operations are being controlled by microwave. Automatically recorded pressures, rates of flow, and tank level readings are instantly and accurately transmitted to headquarters and division stations. To these automatic and unattended control features of microwave, add the privacy of microwave telephone and teletype communication. Integrate with these features the selective remote control of VHF radio for dispatcher-to-car communication, through any fixed station over the entire microwave system . . . and you have a truly modern communication system.

Philco Microwave provides complete tie-in with existing pipe line facilities. Let Philco Microwave help you control your operations more efficiently—at lower costs! For complete information, write to Dept. EE today.

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PHILCO CORPORATION

GOVERNMENT & INDUSTRIAL DIVISION

Major Developments

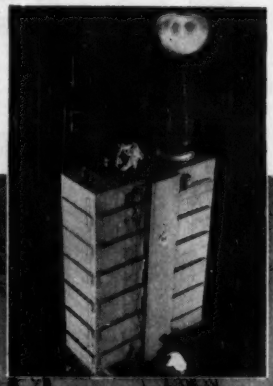
Transformers for TODAY and TOMORROW

TO MEET TODAY'S NEEDS, Allis-Chalmers is building transformers with capacities up to 220,000 kva and others for 345-kv transmission.

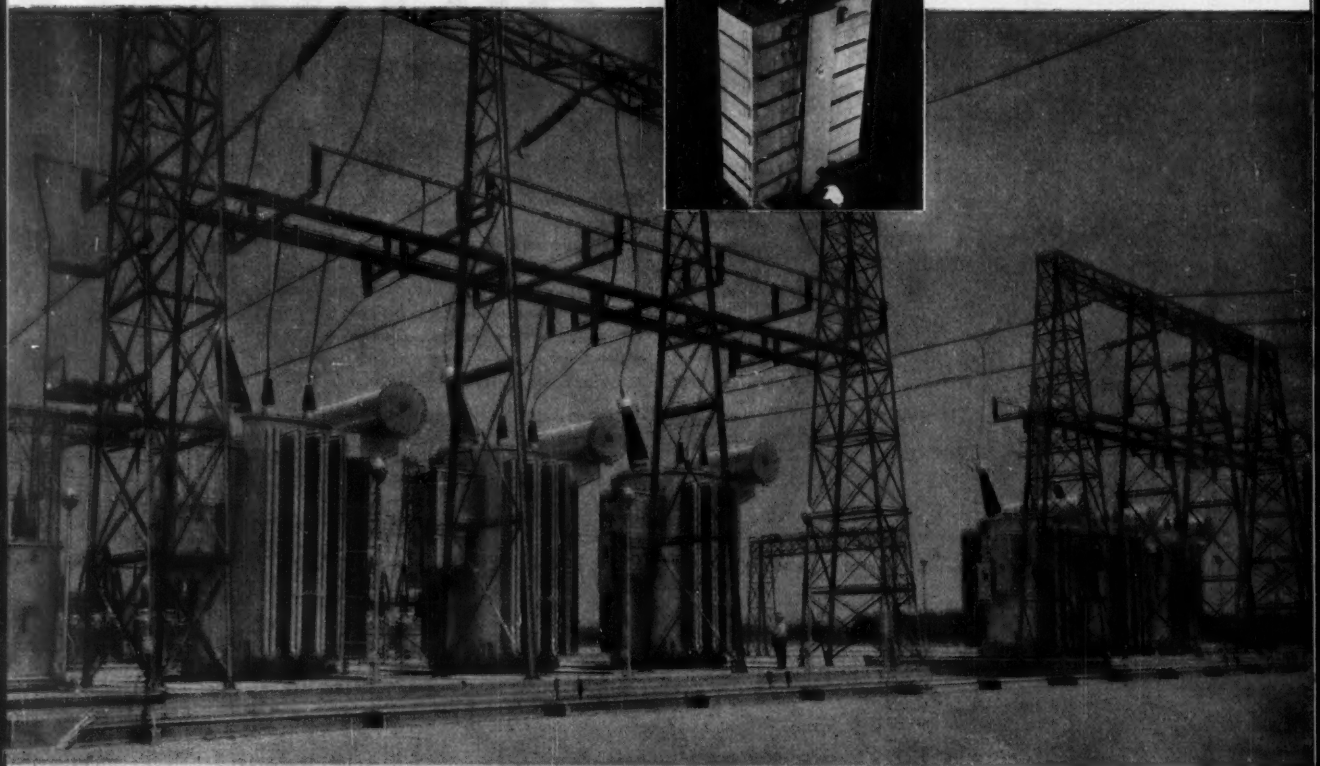
To be ready for tomorrow's requirements, and to add to today's design information, A-C designed and built the 600-kv unit shown below. Tested at design levels and then taken up to breakdown, this pioneering unit has been rebuilt and is now available for testing future extra high voltage power transformers.

This combination of practical experience and development work is your assurance that you can depend on A-C for transformers engineered to meet your requirements . . . all, of course, incorporating *corona-free* design for long, trouble-free insulation life. A-4294

At right: Capable of operation on 600-kv transmission line now — possibly on 880-kv line in the future, this 5000-kva commercial-type power transformer proves that Allis-Chalmers transformer engineering is ready for transmission voltages far beyond present levels.



Below: Two 90,000-kva banks of load ratio control transformers on 230-kv lines of Southern California Edison Company.



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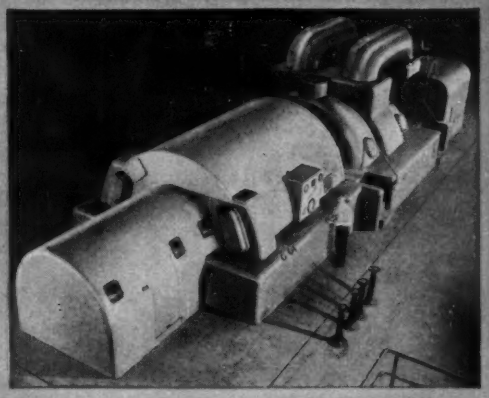
ALLIS-

in Power Equipment

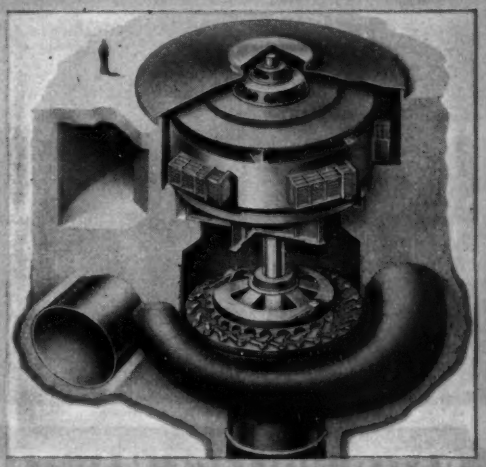
First *Supercharged* Generators

By cutting generator size, supercharged hydrogen cooling permits smaller plant size, lower foundation and crane costs, and smaller breaker and bus structures; now, maximum turbine-generator unit ratings are not limited by mechanical design. A-C turbine generators built for direct rotor conductor cooling have proved themselves in commercial service. The first of these — the world's first supercharged unit — has established a 99.86% availability record during its two full calendar years of operation. And A-C is building a fully supercharged generator affording further economic advantages.



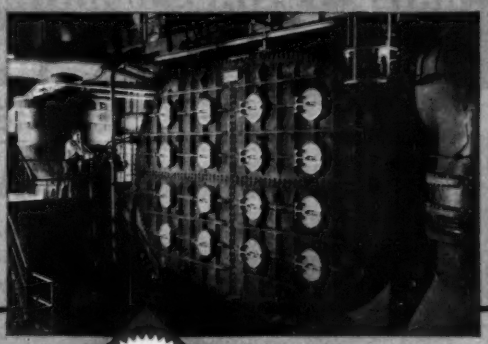
Reversible Pump-Turbine Units

Pioneered by Allis-Chalmers, reversible pump-turbines can solve some troublesome peak load problems. They do this by reducing the amount of equipment formerly needed for pumped storage operation; the single unit operates alternately as a turbine-generator and as a motor-driven pump. One 20,000-hp pump-turbine is now in operation, and four others are in production, with turbine ratings ranging from 12,650 to 120,000 hp. The latter will combine the world's largest motor, with a rating of 102,000 hp, and the largest Francis turbine ever built.



Multi-Steam-Path Condensers

Allis-Chalmers is supplying six 100,000 sq ft surface condensers for the 2,200,000 kw of added private utility capacity being provided for AEC's Ohio diffusion plant. A-C multi-steam-path condensers have consistently helped to cut power costs. With 60 years of experience building over 13,000,000 sq ft of condenser capacity, A-C has the proven engineering and manufacturing facilities to build the largest condensers that might be required.



A-C CHALMERS

ALLIS-CHALMERS

For more information, contact your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

(*Continued from page 38A*)

pulse transformer, type *PT-4*, is a versatile 4-winding unit with 2:2:1:1 turns ratios. Measured characteristics include 120-ohm characteristic impedance, 0.03-microsecond rise time, 20-per-cent droop at 1 microsecond, 40-per-cent droop at 2 microseconds. As a pulse or tripper generator, it may be used in many different blocking oscillator circuits. It may also be used for coupling, impedance matching, etc. For further information write Berkshire Laboratories, 540 Beaver Pond Road, Lincoln, Mass.

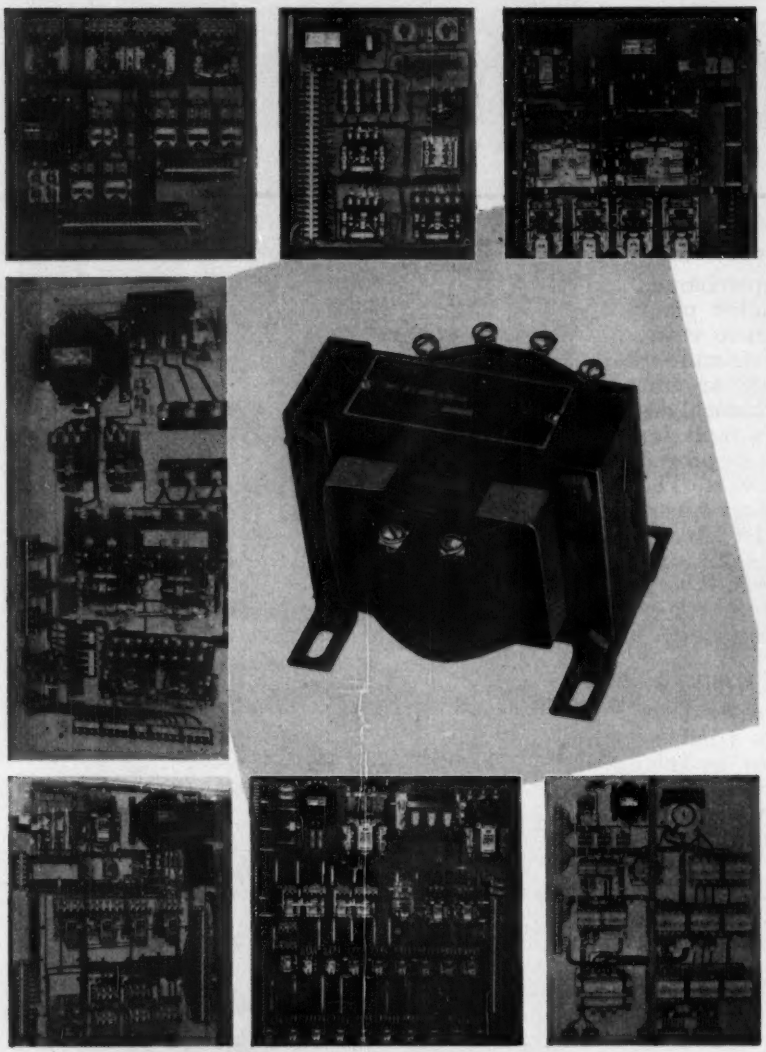
Weston Panel Instrument. A new line of $4\frac{1}{2}$-inch switchboard and panel instruments with clear plastic fronts and "in-line" pointers and dials, has been announced by the Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J. Known as the model *610* group, the plastic fronts admit a maximum amount of light on the dial from the sides, top, and front, and thus eliminate the need for internal illumination under normal operating conditions. This group is available in types and ranges to meet all switchboard and special requirements. Scales are 3.5 inches in length; rated accuracy 1 per cent of full-scale value; size, 4 by $4\frac{1}{2}$ inches. A descriptive bulletin and price list are available direct from the manufacturer.

Standard Piezo Relay. Practical, low-cost, and extremely small cadmium-sulphide crystal photocells introduced by the Standard Piezo Company, Carlisle, Pa., are capable of operating inexpensive sensitive relays directly without an amplifier and thus pave the way to outstanding cost reductions on a wide variety of photoelectric assemblies. Standard types as small as 1/4 inch in diameter by only 1/4 inch deep exclusive of leads deliver from 2 to 5 milliamperes when exposed to light of from 50 to 100 foot-candles intensity with approximately 100 volts applied across cell and load. This means that, on applications where a light source of good intensity can be used, no amplifier is needed. Bulletin *PC-10* giving complete details on Standard *CdS* crystal photocells is available on letterhead request to the manufacturer.

Encapsulated Prescision Resistors. A new "grouped" model of the recently released R- (registered trade-mark) encapsulated precision resistors has been announced by Ohmite Manufacturing Company of Skokie, Ill. The new units are made up of from two to six individual, lug-type Riteohm resistors, arranged end-to-end in a 1-piece, molded resin body. A special Ohmite-compounded resin completely encloses the individual resistors and gives maximum protection against mechanical damage and ambient conditions. A descriptive bulletin, Number *145*, giving full details, can be obtained by writing Ohmite Manufacturing Company, 3664 Howard Street, Skokie, Ill.

G-E Landing Lamp. Development of an improved airplane landing lamp by

(*Continued on page 46A*)



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CONTROL CIRCUIT TRANSFORMERS

Hevi Duty Transformers are specifically designed to reduce the voltage drop to the holding coils of contactors, relays, and similar equipment at peak in-rush periods. Well anchored coil terminals eliminate the need for terminal boards. Notice how these compact, neat appearing Hevi Duty Transformers save valuable panel space. Sizes 20 V.A. to 10,000 V.A. We are experienced in the production of specialty transformers.

Write for data and regulation curves — Bulletin T-5111.

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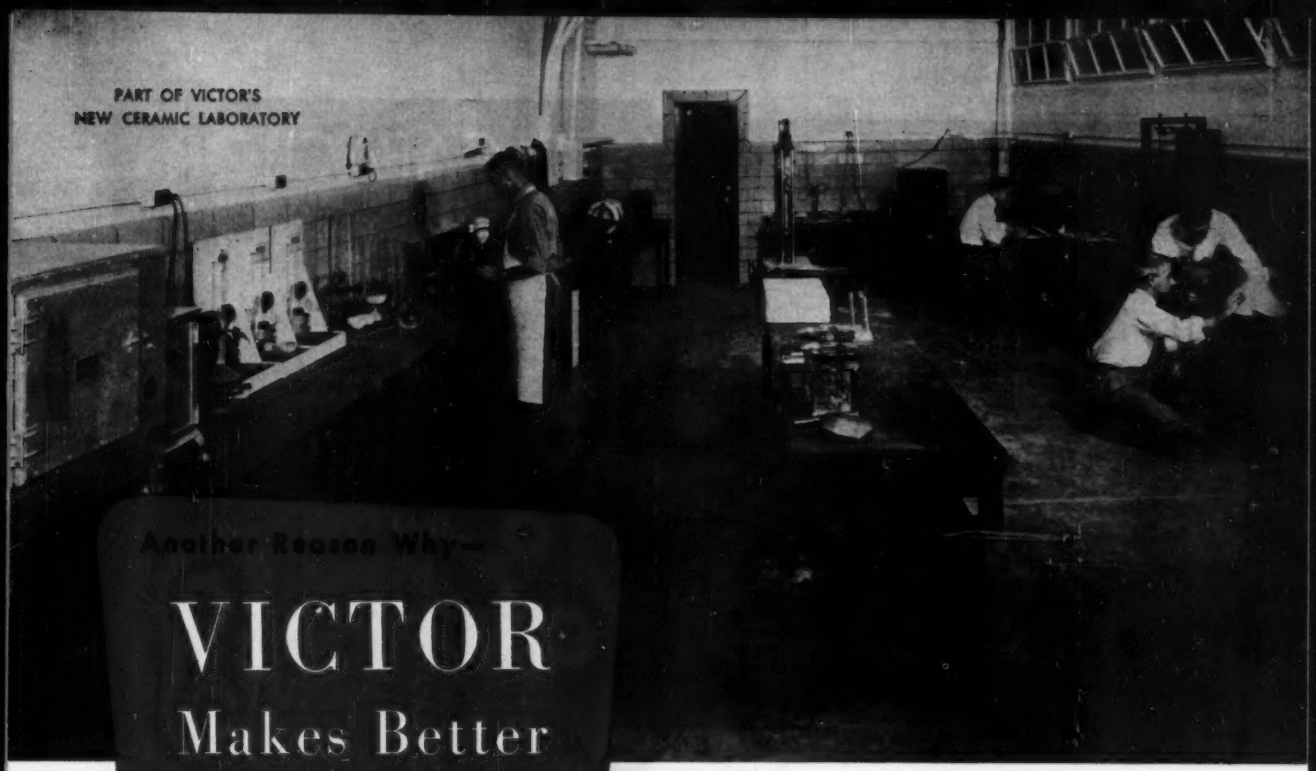
Dry Type Transformers *Constant Current Regulators*



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INDIA:	College of Engineering, Banaras Hindu University, Banaras
ITALY:	Università di Napoli, Laboratorio di Elettrotecnica, Naples
JAPAN:	Showa Electric Wire & Cable Co. Ltd. Kawasaki
NETHERLANDS:	Gemeente-Energiebedrijf, Rotterdam
SPAIN:	Cia. de Inversiones, S. A. (Pirelli), Barcelona
SWITZERLAND:	Emil Haefely & Cie. A. G., Basle

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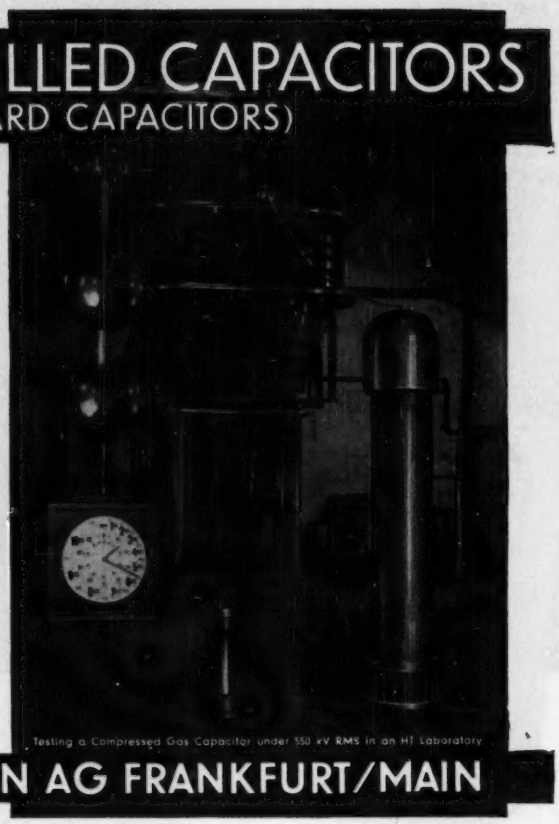

Testing a Compressed Gas Capacitor under 550 kV RMS in an HT Laboratory

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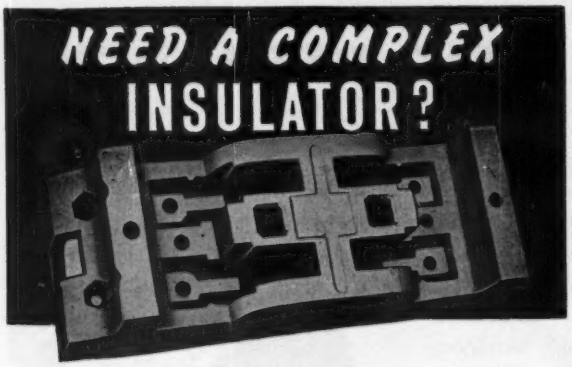
NEED A COMPLEX INSULATOR?



If you have an insulator design that looks like a Chinese puzzle, Universal can produce it for you in porcelain . . . with every detail meeting your exact specifications, every piece held to close tolerance and uniform body density.

Universal Porcelain combines high dielectric and physical strength . . . insulators are unaffected by hot arcing and thermal shock; resistant to temperatures, chemicals, moisture, fumes. Intricate or simple, long run or short, specify economical long-lifed Universal Porcelain Insulators on your next job.

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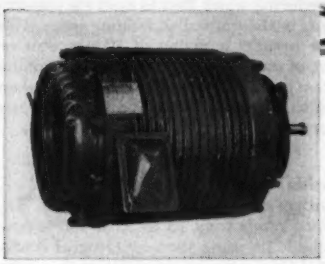
SILICONES

give motors more muscles



RELIANCE 20 hp (class H) Motor
330 Pounds Lighter than Conventional Design

For maximum safety, carrier planes are fueled and defueled immediately before take-off or after landing. Several fast reversible pumps are used, any of which can fill or empty a plane's tanks within minutes. The pumps and their motors are big and heavy, however. So much so that the Navy challenged manufacturers to produce new motors which would combine top dependability and absolute minimum weight.

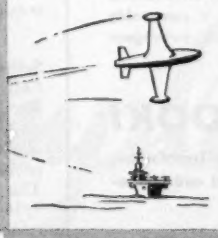
The Reliance Electric & Engineering Company attacked the problem both inside and out. They made the entire TENV frame and the mounting brackets of aluminum, ribbed for maximum heat dissipation. On the inside, silicone (Class H) insulation raises the power-per-pound ratio by over 50%, and also provides extra resistance to weathering and salt spray. As a result, the finished motors are among the smallest and lightest ever made in their class. The 20 hp unit, for example, weighs some 330 pounds less than the conventional 20 hp motor. Already they have been specified for the new super carriers Forrestal and Saratoga.

That's typical of the "design-ability" of Class H insulation made with Dow Corning silicones. Adaptable to any electrical equipment and costing only slightly more than the next best class of insulation, it can be used to increase the power-per-pound ratio or to extend the life of electrical machinery over ten times. For better performance, lower maintenance costs, and greater sales appeal, alert design and management men specify Class H insulation made with Dow Corning silicones

first in silicones

DOW CORNING
CORPORATION

MIDLAND, MICHIGAN



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Dow Corning Corporation, Dept. H-20, Midland, Michigan
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- ☐ List of Class H Motor and
- ☐ Class H Transformer Manufacturers
- ☐ "Tall Tales and Fabulous Facts" about silicone products

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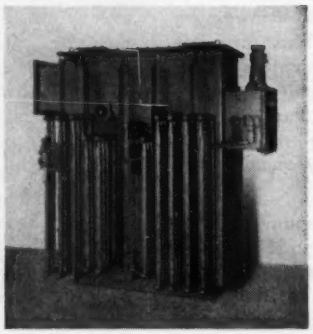
No need to fret and stew once you've ordered a Niagara Transformer! Erie Electric's reputation for reliability was earned by paying attention to details . . . details that are important to you and your satisfaction. There's no mass production hysteria here, no "spot testing" of huge quantities, no compromise with quality. In every phase of production each transformer is carefully checked and re-checked to be sure it is exactly the way you want it.

Engineers everywhere have learned that Erie Electric's high calibre craftsmanship produces transformers that are safe, dependable and economical. And what's more, they're delivered on time, too! So, if you're looking for a quality transformer at a competitive price . . . let us quote on your next one.



NIAGARA non-inflammable, liquid filled unit substation transformer, 750 KVA, 60 cycle, three phase 7200-208Y/120 with H. V. liquid filled three position disconnect switch with remote operating handle and L. V. removable throat for connection to switchgear or bus duct.

Send for this **FREE BOOK!**

Get acquainted with all the plus values in a Niagara Transformer. Write on your letterhead for this big, fully illustrated and informative book.

ERIE ELECTRIC CO., INC., 114 CHURCH ST., BUFFALO, N. Y.

OFFICES IN ALL PRINCIPAL CITIES

POWER • LIGHTING • LOAD CENTER • OIL-IMMERSED • DISTRIBUTION • UNIT SUBSTATION • DRY-AIR COOLED • NON-INFLAMMABLE

(*Continued from page 42A*)

General Electric's Lamp Division has been welcomed by air-line operators, by aircraft manufacturers, parts manufacturers, and by the military. Rated at 600 watts, the new lamp (number *4559*) is said to provide: a longer, more uniform service life than that of its predecessor; more stable beam pattern than heretofore; lower maintenance costs, and greater assurance of safety. The new landing lamp is identical in all respects with the lamp it replaces except for its filament construction. Unlike the old filament in the lamp, which employs two supports looped around the filament, the new lamp's filament uses no supports.

New Class B Ignitron. A new size *B* ignitron with provisions for thermostat mounting has been developed by National Electronics, Inc., Geneva, Ill. This tube, designated *NL-1051*, utilizes a new protection system which depends entirely upon tube temperature and is similar to the thermal protection built into motors. This system permits a substantial water saving by reducing water flow to meet the requirements of the particular welding job. This often permits a saving of 80 per cent or more of water. A further refinement of the system permits an on-off water saving when used with a solenoid water valve and at the same time eliminates condensation.

Sensitive High-Frequency Detector. A sensitive detector for signals in the frequency range from 25 to 5,000 mc is now available by using the new General Radio type *1216-A* unit i-f amplifier with a type *874-MR* mixer rectifier and a suitable unit oscillator. The signal to be detected is heterodyned in the crystal mixer with a signal from a local oscillator to give a 30-mc difference frequency which is fed to the i-f amplifier. The small size and light weight of the 30-mc amplifier combine with the broad bandwidth, good selectivity, and excellent shielding make the instrument much more useful for detector work.

RCA to Produce Ferrite Products. The Tube Division of the Radio Corporation of America has announced its first commercial ferrite cores; magnetic elements for electronic components used in television sets, radios, and sound communications equipment. Ferrites, magnetic ceramics made from metallic oxides, are rapidly replacing conventional powdered iron as the core material of electronic components because of their higher electrical efficiency, greater sensitivity, and compactness.

Self-Generating Selenium Photoelectric Cell and "Sun Battery." International Rectifier Corporation, El Segundo, Calif., has announced a new, low-cost, mounted selenium photoelectric cell designed especially for engineers and experimenters. This *B2M* photocell measures 23/32 by 7/16 inch and is mounted by a self-contained foot bracket extension. The active area of the unit is only 0.26 square inch, yet it generates an average output of 60

(*Continued on page 52A*)

It's Fun to Be FIRST!

Even though Simplex has proudly announced many "Firsts," somehow the thrill never wears off. That's why we're so proud of our latest "First," announced last fall. It is the approval by the Underwriters' of Simplex WD-75 Wire as "Type RHW." It is the first wire to bear this approval.

Obviously a new product should do something for you that an old one doesn't do. Here's what Simplex WD-75 Wire will do:

- It can be used as general-purpose wire in BOTH wet or dry locations at a copper temperature of 167° F. (75° C.). No wire was approved to do that before.
- Depending on the ambient temperature, Simplex WD-75 can carry from 18 to 52% more amperes in the same size conductor in wet locations than Type RW Wire. That's good — saves you money, too.

Simplex WD-75 is gentle with remodeling costs, too. If your conduits are filled now to their rated capacity, and if additional amperes are needed, *don't* tear out your conduits. You need only pull out your present wire and pull in Simplex WD-75.

Simplex makes Type RHW Wire as ANHYDROPRENE WD-75 for use in conduits and ducts, and ANHYDREX WD-75 for direct burial in the ground. Simplex folder No. 1018 has more details about this wire. Why don't you write for it today?

Simplex **ANHYDROPRENE WD-75**
ANHYDREX WD-75

SIMPLEX WIRE & CABLE CO., 79 Sidney Street, Cambridge 39, Mass.

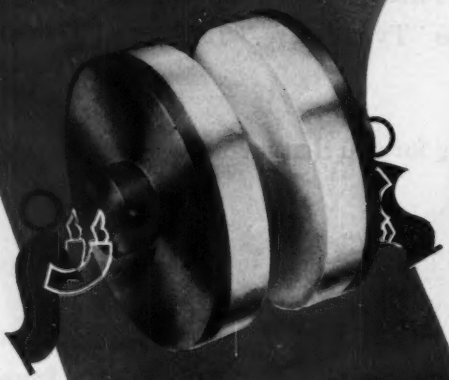
STACKPOLE

SG Series SILVER GRAPHITE FORMULAS

for longer life plus greatly improved contact drop

30% harder than conventional silver-graphite SG series contact materials, Stackpole silver-graphite greatly prolongs contact life under short circuit conditions. Far better contact drop is assured. Wearing qualities are tremendously improved. Contacts can be made in practically any desired shape or size.

NOTE: Stackpole contacts are sold only for original equipment purposes.



THEY SOLVE A LOT OF CONTACT PROBLEMS!

STACKPOLE

CW Series SILVER-TUNGSTEN FORMULAS

for high-amperage uses

In many typical cases—from circuit breakers to other heavy-duty equipment—Stackpole CW series silver-tungsten contacts have permitted substantial increases in amperage rating while making it entirely practical to *reduce* the size of equipment. On especially difficult applications, one of these units operating against a Stackpole silver-graphite contact (see above) provides truly outstanding efficiency.

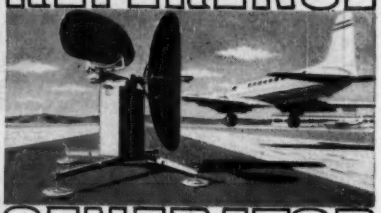
FOR HELPFUL DATA ON CONTACT SELECTION AND USE . . . write for 36-page Stackpole Catalog 12

Stackpole Carbon Company, St. Marys, Pa.

STACKPOLE

Stackpole contact types include: SILVER GRAPHITE; SILVER LEAD OXIDE; SILVER NICKEL; SILVER MOLYBDENUM; SILVER TUNGSTEN; COPPER GRAPHITE; SILVER-COPPER GRAPHITE; GOLD-GRAPHITE; SILVER IRON OXIDE and many special grades

REFERENCE



GENERATOR

for remote position indication

"Sixth sense" is provided by the midget generator whose rotor is turned by scanning or tracking radar.

How many applications for these precision electro-mechanical units! Any revolving shaft can be closely monitored through reference generator output in a closed loop control system.

OSTER Avionic Products conform to military specifications for altitude, high and low temperature, life, shock, vibration, humidity, and fungicidal treatment.

You can depend on Oster quality in rotating components for automatic control.

OSTER two-phase Reference Generator, Type 212055. Develops 40 volts, 35 cycles when driven 2100 rpm. Use it on rotary or rate indication applications.

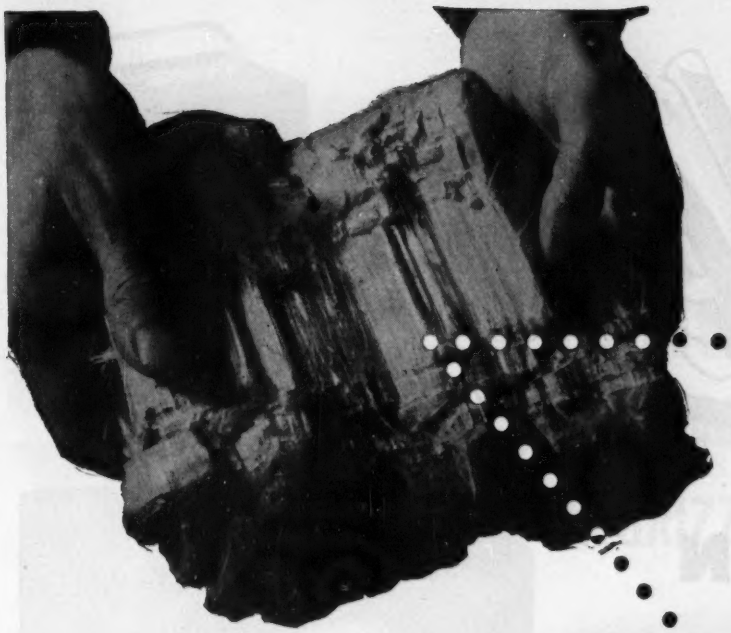
Other OSTER Avionic Products include:

- Special motors: Servos, Synchros, Drive Motors, Blowers and Fans for use with D-C and A-C supply voltages in common usage on aircraft and ground equipment.
- Synchro Generators, Control Transformers, Transmitters, Differentials, Receivers, Resolvers and Two-Speed Synchros.
- Tachometer Generators and Reference Generators.
- Aircraft Actuators, both linear and rotary.

Insure dependability...specify Oster®

For your copy of our illustrated pamphlet No. 974 on Oster Avionic Products, write John Oster Manufacturing Co., Avionics Division, Dept. 468, Racine, Wisconsin, U.S.A.

JOHN OSTER
MANUFACTURING COMPANY
AVIONIC DIVISION
RACINE, WISCONSIN



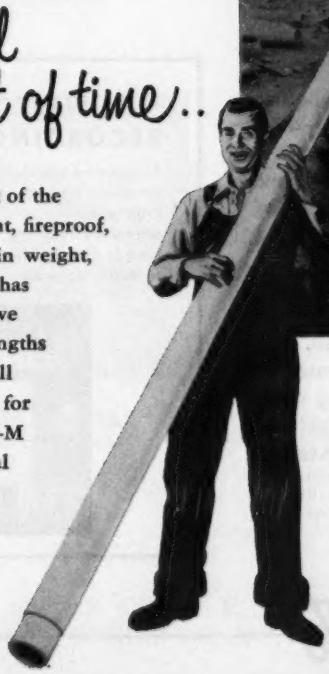
From the magic mineral

...ASBESTOS

come these strong, durable

TRANSITE DUCTS

made to stand the test of time..



Transite* meets every requirement of the ideal duct material. It is permanent, fireproof, corrosion resistant, strong, light in weight, smooth-bored, non-inductive, and has rapid heat dissipation. No protective coating is required. The 10-foot lengths are rapidly assembled. Transite will outlast other duct materials. Write for new, free brochure showing how J-M Transite Ducts can effect substantial savings in both installation and maintenance of cable subways. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

Available In Two Types:

TRANSITE CONDUIT

Thick walled, used for exposed work, or buried without concrete casement saves time, labor, materials.

TRANSITE KORDUCT

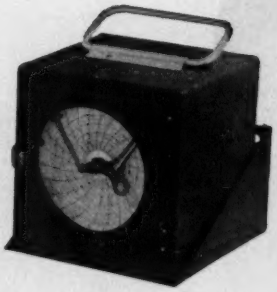
Thinner walled for installation in concrete. Used for high-voltage lines, its high thermal conductivity cuts operating losses.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

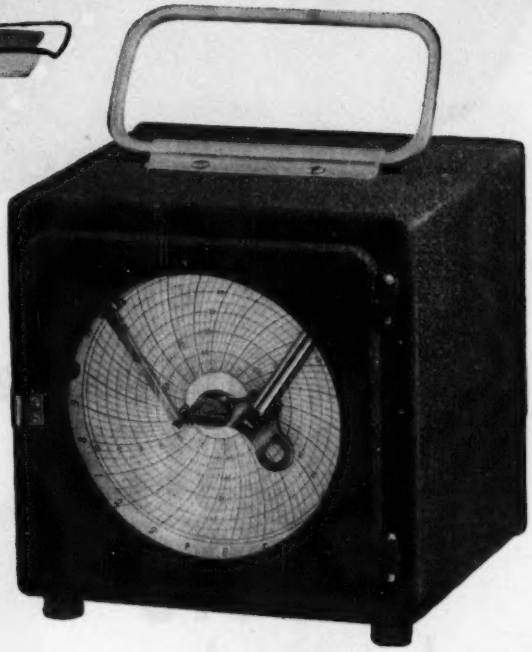
*Trade mark registered

New



WESTON
miniature
Electrical Recorder

EXTREME COMPACTNESS...CORMAG® SELF-SHIELDING MECHANISM... A-C AND D-C MODELS



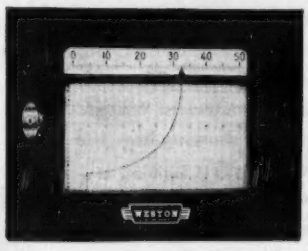
Employing the Weston CORMAG mechanism, this new recorder combines a high degree of shielding with new compactness and light weight. For example, the magnetic field created by a conductor carrying 15,000 amperes at a distance of 3 feet would cause a temporary error of less than 1 per cent. Over-all size is only 6¾" x 6¼" x 7" deep; chart size 4" dia.; weight only 1½ lbs.

It's the ideal instrument for recording ampere-hour demand—checking overloads or unbalanced conditions—monitoring radio detectors—recording current and duration in electroplating and metal refining—recording speeds—making life tests on batteries, lamps, etc.

Available in required ranges for A-C or D-C voltage or current measurement needs. Also furnished with bracket for wall mounting; and with flange case for flush panel mounting. Bulletin available giving complete specifications and prices . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey. 7553

WESTON SIMPLIFIED RECORDING POTENTIOMETER

Sets a new standard for sound, simplified design—for simplicity and economy of maintenance—for sustained high accuracy and dependability. Ranges changed simply by inserting required range standards. Chart speeds changed by simple screwdriver adjustment. All features described in bulletin. Send for your copy.

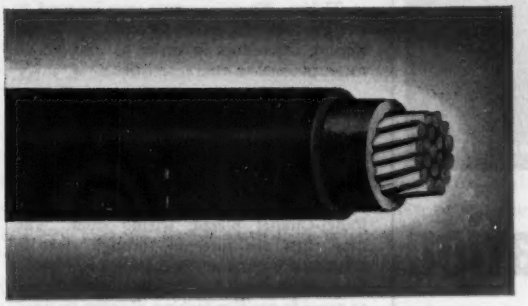


WESTON *Instruments*

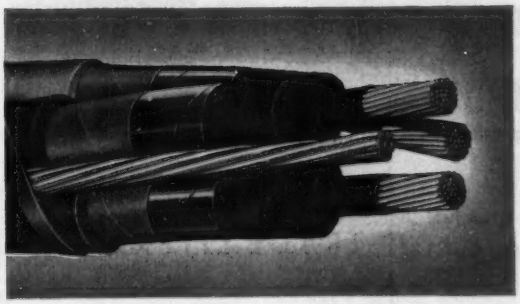
10 reasons why

you should specify, buy,

install U. S. GRIZZLY® POWER CABLES



U. S. Grizzly Power Cable, 600 volts – Type RR single conductor, Hydrosec® – S heat- and moisture-resistant insulation, Neoprene jacket.



U. S. Grizzly Power Cable, 15,000 volts – Type RR – 3-conductor, Uskorona® – ozone-resistant insulation – shielded – Neoprene jacket.

1. Lighter in weight than lead-sheathed cables and lead-sheathed armored cables.
2. Greater flexibility
3. Easier to handle during installation
4. Easier to splice, tap and terminate
5. More resistant to chemical corrosion
6. Unaffected by stray currents
7. Better protection against weathering
8. Longer life
9. Cost less
10. Made by United States Rubber Company, the *only* electrical wire and cable producer to grow its own natural rubber, make its own synthetic rubber and manufacture its own plastics

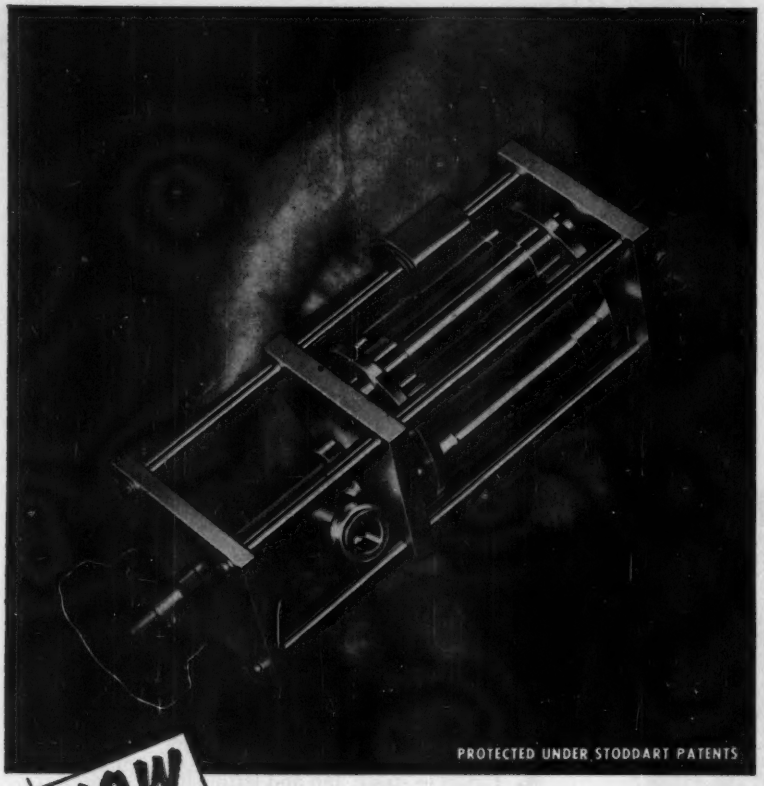
U. S. Grizzly Power Cables are used for general power distribution, and can be installed in conduits, underground ducts, buried directly in the ground, or installed aerially. Neoprene jacket protects against acids, alkalies, oils, and mechanical damage and weathering. (All IPCEA and NEMA specifications complied with.)

Write to address below for free copy of illustrated reference manual on U. S. Electrical Wires and Cables for the electric utility industry. It lists the type of cable best suited for specific requirements.

US RUBBER

UNITED STATES RUBBER COMPANY

ELECTRICAL WIRE AND CABLE DEPARTMENT, ROCKEFELLER CENTER, NEW YORK 20, N. Y.



NOW

Precision Attenuation to 3000 mc!

TURRET ATTENUATOR featuring "PULL-TURN-PUSH" action

SINGLE "IN-THE-LINE" ATTENUATOR PADS and 50 ohm COAXIAL TERMINATION

FREQUENCY RANGE:
dc to 3000 mc.
CHARACTERISTIC IMPEDANCE:
50 ohms
CONNECTORS:
Type "N" Coaxial female fittings each end
AVAILABLE ATTENUATION:
Any value from .1 db to 60 db
VSWR:
<1.2, dc to 3000 mc., for all values from 10 to 60 db
<1.5, dc to 3000 mc., for values from .1 to 9 db
ACCURACY:
±0.5 db
POWER RATING:
One watt sine wave power dissipation

Send for free bulletin entitled "Measurement of RF Attenuation"

•

Inquiries invited concerning pads or turrets with different connector styles

STODDART AIRCRAFT RADIO Co., Inc.
6644-B Santa Monica Blvd., Hollywood 38, California · Hollywood 4-9294

(*Continued from page 46A*)

microamperes at 100 foot-candles illumination. As a result of this high output the *B2M* photocell can be connected directly to a 0–1 milliammeter by its 6-inch pigtail leads and used as a light-measuring device. Another application of the *B2M* photocell is its operation as a "sun battery" to convert solar energy into a power supply for transistorized equipment and portable devices. For additional technical information write International Rectifier Corporation, 1521 East Grand Avenue, El Segundo, Calif., for bulletin *ER-205*.

Thorax RM Arrester. The new Ohio Brass valve-type Thorex lightning arrester for the protection of equipment with low impluse insulation strengths is intended for use on motors and generators, as well as dry-type transformers and older pieces of oil-insulated apparatus. It has exceptionally low sparkover and IR discharge voltage characteristics. The porcelain top construction permits closer spacing and reduced mounting clearance. The Thorex *RM* arrester is available in 14 different line-to-ground voltage ratings from 3 kv to 27 kv. These arresters may be used in conjunction with parallel-connected, wave-sloping capacitors in order to gain maximum protective characteristics.

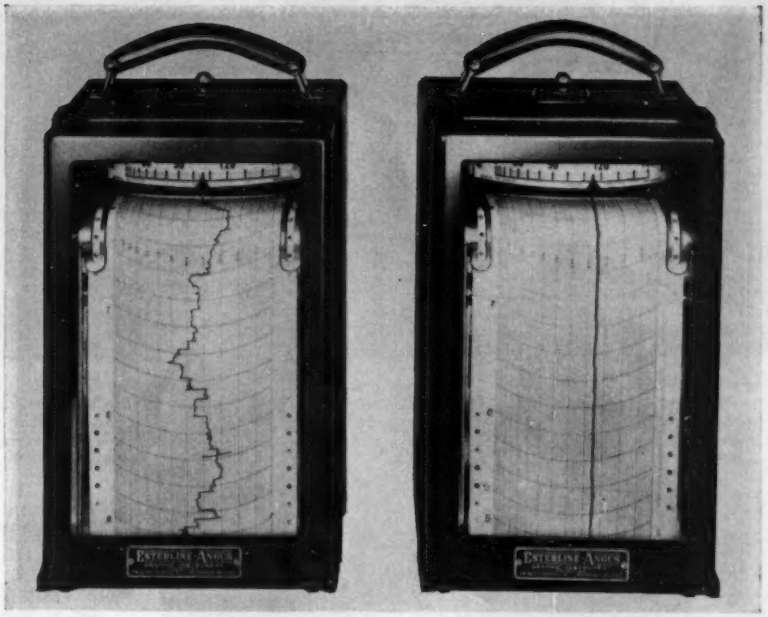
New Cover Clip With Hinge Action. It is impossible for metal to become loose and foul controls with the new safety cover clip developed by Stahlin Brothers Fibre Works, Inc., Belding, Mich., for their Panel-Chanel plastic wiring duct. The new clips are inserted through slots in sides of the channel, and covers are press-fitted to the clips. The clips are designed to provide positive locking of cover to sides. To provide for easy maintenance or wiring changes, the new clips allow covers to swing back, completely exposing all wiring. Channel covers do not have to be removed from the panel, and need for unlacing wires is eliminated. Wiring changes are only a matter of minutes with the new development. With Panel-Chanel, the perforated plastic sides are fastened to the control panel and wiring is laid in the duct. Wires are pulled through proper lead-off holes and connected to electrical components.

TRADE LITERATURE

Repetitive Manufacture Power Transformers. A 2-color bulletin describing repetitive manufacture (built in accordance with American Standards Association Standard *C57.12a*) power transformers has been announced as available by the General Electric Company, Schenectady 5, N. Y. The 40-page booklet, designated *GEA-6108*, cites the application and features of standardized single-phase and 3-phase units, ranging from 501 to 10,000 kva.

(*Continued on page 56A*)

±1% stable voltage in face of 30% line variations

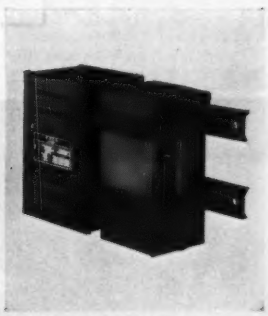


TYPICAL EXAMPLE OF SOLA VOLTAGE REGULATING ACTION. The recording on the left represents a fairly common condition of voltage fluctuation on a 115v line. The chart on the right was made at exactly the same time from the same line. The primary of the Sola regulator was fed the voltage charted on the left, the voltage charted on the right represents its secondary output, regulated to within ±1% of 115v.

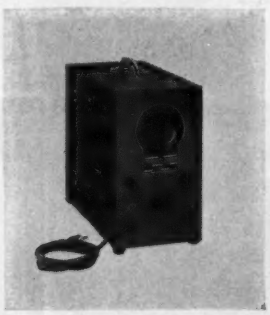
Voltage-sensitive electrical and electronic equipment can not operate to performance specifications under conditions of voltage fluctuation. A source of constant voltage can be easily supplied with a Sola Constant Voltage Transformer . . . built-in as a component, or used externally as an accessory.

Among the chief advantages of Sola regulators are: dependable, automatic operation (static-magnetic regulation) . . . substantially instantaneous response (1.5 cycles or less) . . . no maintenance (no moving or expendable parts) . . . and immediate availability (40 stock units in a wide variety of ratings).

STANDARD TYPE CV
Twenty-nine units from 15va to 10kva in a common power line and filament voltage ratings . . . regulation ±1% or less with a total primary variation of 30% . . . for electronic and electrical equipment requiring close regulation.



HARMONIC-NEUTRALIZED TYPE CVH
Six units from 60va to 2kva . . . input range 95-125v, output 115v . . . all the features of the Standard Type CV plus a harmonic neutralizer circuit . . . ±1% regulated voltage with less than 3% harmonic distortion.



ADJUSTABLE, HARMONIC-NEUTRALIZED TYPE CVL
Two ac voltage supply units, 250va and 500va . . . input range 95-125v, output range adjustable from 0-130v . . . regulated ±1%, harmonic distortion less than 3% . . . for general lab work, testing and other applications.

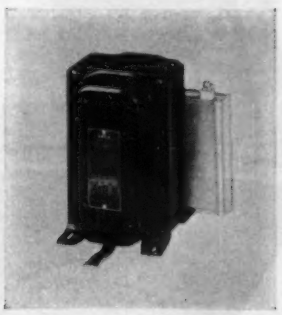


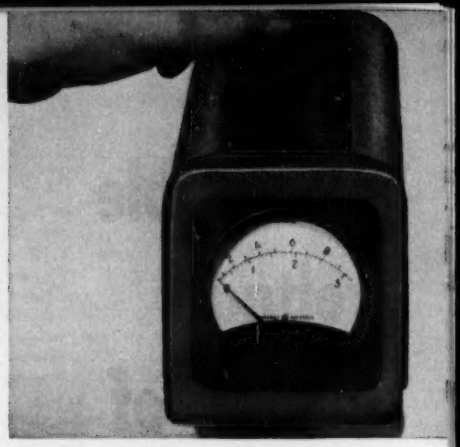
PLATE AND FILAMENT TYPE CVE
Three units in popular power supply ratings . . . a single, compact source of filament and plate supply voltages . . . regulated to within ±3% or less with line voltage variations of 100-130 volts . . . supplied with separate capacitor for chassis mounting.

SOLA *Constant Voltage* **TRANSFORMERS**

Write for a 28 page bulletin with complete electrical and mechanical specifications on these Sola units. Request BULLETIN 5H-CV-200.

Transformers for Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Plastic Signs
SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • BOSTON: 272 Centre Street, Newton 58, Massachusetts
NEW YORK 35: 103 East 125th Street • LOS ANGELES 26: 2025 Sunset Boulevard • PHILADELPHIA: Commercial Trust Building
CLEVELAND 15: 1836 Euclid Avenue • KANSAS CITY 2, MISSOURI: 406 West 34th Street • Representatives in Other Principal Cities

Instruments for Vibration Testing



DIRECT READING of vibration measurements is at point of testing and no other instruments are required. The range-changing switch provides five ranges of displacement and six ranges of acceleration measurement.

CUT REJECT AND MAINTENANCE COSTS

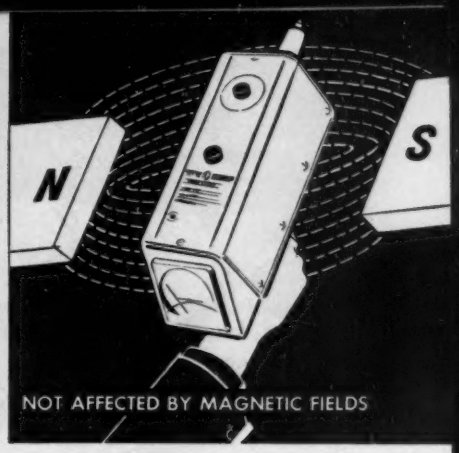
Excessive vibrations of your products and capital machinery can easily result in poor quality and even shutdowns if not discovered promptly. The new G-E portable vibration meter provides a completely self-contained means of obtaining vibration measurements over a frequency range of 10 to 250 cycles per second.

No trained operators are required for this simplified instrument. All the operator need do is turn the selector switch to "Displacement" or "Acceleration" and press the switch on the pistol-grip handle.

MORE NEWS ABOUT

LIGHT-BEAM VIBRATION INDICATOR locates points of excessive machinery vibration. Available with either of two scales: 0–15 or 0–30 mils. The frequency response is 15 to 250 cps.

RECORDING VIBROMETER measures and records frequency, displacement, and wave shape of mechanical vibration. Frequency range: 10 to 120 cps.



WIDE VARIETY OF APPLICATIONS is possible for both testing and inspection of plant equipment. This new instrument is exceptionally versatile because of its high accuracy at low scales. It is especially valuable in installing and maintaining rotating and reciprocating equipment. Typical industrial applications range from motors (left) to turbine-generators (above). Portability permits convenient use in laboratory or factory.

NOT MAGNETIC-SENSITIVE, the new meter is ideal for vibration measurements in areas of stray fields and in the vicinity of magnetic coils. Common hearing-aid batteries will operate this instrument for 20 hours.

General Electric Announces . . . .

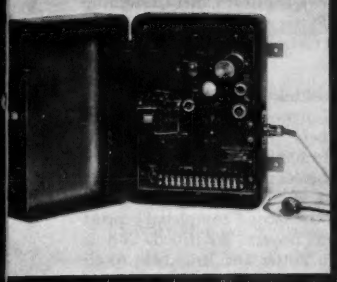
New Portable Vibration Meter

for direct reading of acceleration and displacement

The new General Electric portable vibration meter provides a quick, simplified means of locating excessive—and costly—machinery vibrations.

Designed for use on production tests or your plant equipment, this new instrument gives a degree of sensitivity never before offered in a hand-held vibration meter. In measuring *both* displacement *and* acceleration, this new equipment will measure 3 to 300 mils peak-to-peak displacement and 0.03 to 10 G peak acceleration, full-scale values. Readings of ¼ mil can be obtained.

OTHER G-E VIBRATION INSTRUMENTS



GENERAL ELECTRIC COMPANY, Section A605-70
SCHENECTADY 5, NEW YORK

Please send me a copy of the bulletin(s) checked below:

- ☐ **GEC-1247 Portable Vibration Meter**
- ☐ **GEC-1212 Vibration Detector**
- ☐ **GEC-1204 Vibration Relay**
- ☐ **GEC-853 Vibration-measuring Equipment**
- ☐ **GEC-1016 Measuring Equipment Catalog**

NAME.....

COMPANY.....

STREET.....

CITY.....**ZONE**.....**STATE**.....

VIBRATION RELAY helps protect normally unattended equipment by initiating a signal when excessive vibration occurs. Frequency range of relay is 5 to 300 cps.

VIBRATION DETECTOR is a lightweight crystal accelerometer used with associated equipment in measuring acceleration. The frequency response is less than 1 decibel rise at 1000 cps.

SEE THESE AND OTHER G-E INSTRUMENTS at the Instrument Society of America Show, September 15–21, Commercial Museum, Philadelphia, booths 531–537.

GENERAL ELECTRIC

HAND YOUR SPECIAL TRANSFORMER PROBLEMS TO...

Standard
TRADE MARK

YOU CAN SAVE many valuable man-hours and production hours by placing your special transformer problems in the capable hands of experienced STANDARD TRANSFORMER engineers. STANDARD engineers can easily detail all of your transformer requirements and oversee their manufacture from beginning to end. There's a STANDARD representative near you. Call him today!

300 KVA indoor unit sub-station or load center, consisting of high voltaged, fused air brake switch and low voltage section with circuit breakers and transformer

Standard
THE STANDARD TRANSFORMER COMPANY
WARREN, OHIO
REPRESENTATIVES IN PRINCIPAL CITIES

(Continued from page 52A)

New Condenser Bulletin. Design and engineering features of Allis-Chalmers' condensers (capacitors) and facilities employed in their manufacture are described in a new 24-page bulletin released by the company. The bulletin includes illustrations of many types of condensers; conventional, single elbow, and twin inlet, along with sketches showing the many features of the company's new multisteam path condensers. "Steam Condensers," *19B7987*, is available on request from Allis-Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

Welding Book. The latest developments in the science of welding aluminum are described by the Aluminum Company of America in the completely new book, "Welding Alcoa Aluminum." In the 176-page book photographs and drawings illustrate practical methods for welding aluminum. Copies of this new book are available from Aluminum Company of America, 733 Alcoa Building, Pittsburgh 19, Pa.

Properties of Tin. A completely revised edition of "The Properties of Tin," has been issued by the Tin Research Institute. The original compilation was published by the institute in 1934 and was reprinted in 1937; for some years it has been out of print awaiting full revision. The new editions aim to present all the published atomic and nuclear, physical, physicochemical, and metallurgical data concerning pure tin, but does not give data for tin alloys, which are covered in a separate publication of the Tin Research Institute. The book is freely available to libraries and research laboratories, or to anyone engaged in scientific studies. Requests should be addressed to the Tin Research Institute, Inc., 492 West Sixth Avenue, Columbus 1, Ohio.

Patterson-Emerson-Comstock, Inc., Booklet. A new 44-page booklet illustrates and geographically describes many recent electrical installations by Patterson-Emerson-Comstock, Inc. Send all inquiries for booklet to Wray Dudley, Chief Consulting Engineer, Patterson-Emerson-Comstock, Inc., 313 East Carson Street, Pittsburgh, Pa.

Relay Symposium Booklet. A complete reprint of all papers given at the Relay Symposium held at Oklahoma Agricultural and Mechanical College comprises an 84-page booklet published by Potter and Brumfield, Princeton, Ind. The present booklet is the second completed reprint of symposium papers published and is available from Potter and Brumfield to all interested persons in the electrical and electronic industries.

Corrosion Control. "Corrosion Control of Electrical Structures and Equipment" is being offered, free of charge, by Subox, Inc., Fairmount Plant, Hackensack, N. J. This pamphlet is designed to be of assistance to field operating men of the public utilities, in planning their painting and getting the most for their money.

How Well Does Your Present Source Compare With National's COMPLETE Facilities For Motor and Generator Repair

Most motor repair shops can perform some of the operations listed below. Very few can handle them all. These are not routine operations, but extras which require expensive specialized equipment and experience. National service includes all 17 operations. How does your present repair source compare?

plus value operation	*available at National*	*at your present repair source*
1. redesigning and modernizing by competent engineers	yes	
2. vapor degreasing to insure good bonding of varnish	yes	
3. corncob blasting to prepare surfaces like new	yes	
4. rebuilding and remachining to standard of mechanical fits	yes	
5. temporary hotbanding to seat coils in slots	yes	
6. hot rerolling of permanent bands	yes	
7. grinding and polishing of journal shafts	yes	
8. vacuum impregnating	yes	
9. dynamic balancing	yes	
10. grinding and polishing of commutator at top operating speed	yes	
11. load testing	yes	
12. high frequency testing	yes	
13. electronic bar-to-bar and high sensitivity ductor testing	yes	
14. surge comparison testing	yes	
15. high potential ground testing	yes	
16. magniflux testing	yes	
17. anti-friction bearing inspection	yes	
Total	17	

If you can't answer "yes" for your present source on all 17 operations, you're taking unnecessary chances on getting less than the best repair work. You can't tell in advance on which jobs National equipment and National know-how will pay off in improved performance or longer life. So play it the one safe way — make National your first source for *all* motor and generator repairs.

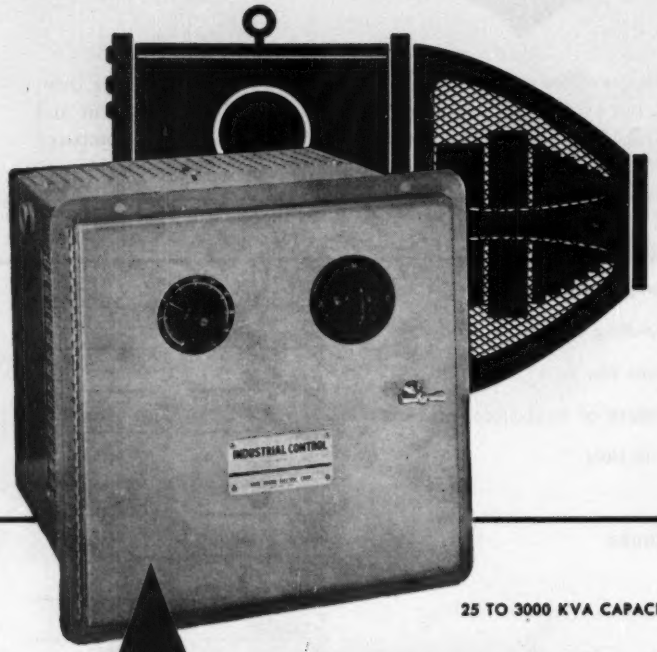
For more details on why the motor or generator you send to National will often come back better than new, call your nearby National field engineer today. Or drop us a line for his name and address.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A.

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Completely New Automatic Generator Voltage Regulator



25 TO 3000 KVA CAPACITIES

THE "Autostatic" BY LAKE SHORE

Here . . . for the first time . . . is a voltage regulator with no moving parts or electronic tubes to wear or fail. The new AUTOSTATIC regulator eliminates maintenance expense, yet costs no more than comparable mechanical units.

In addition, the AUTOSTATIC operates with a speed and accuracy impossible to units having moving parts. It reacts almost instantaneously to correct voltage fluctuations caused by changes in the generator load. There is no time lag because of inertia and friction. Output fluctuations are reduced to a negligible quantity, both in magnitude and duration.

The AUTOSTATIC is available in three sizes with capacities of 25 to 100 KVA, 100 to 400 KVA, and 400 to 3000 KVA.

1880-L8

Write today for Bulletin 1517.

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LAKE SHORE ELECTRIC CORPORATION

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Review of Input and Output Equipment Used in Computing Systems

(March 1953)

The Joint AIEE-IRE-ACM Computer Conference took place on December 10–12, 1952, in New York, N. Y., to discuss the characteristics and performance of input-output equipment as it applies to large-scale electronic digital computers. The conference was held under the direction of the Joint Committee appointed by the Committee on Computing Devices of the American Institute of Electrical Engineers, the Electronic Computers Committee of the Institute of Radio Engineers, and the Council of the Association for Computing Machinery.

Input-output equipment presents an ever-changing and expanding problem and encompasses a very broad field of devices. This conference stressed those devices which have been brought to the point of working equipment by the various computing groups in an attempt to acquaint a large body of engineers with the present status of the art. The 142 printed pages contain 27 papers and discussions, representing a fairly complete documentation of the input-output art as it existed at the time of publication.

Publication *S-53* is available at the price of $4.00 to members and nonmembers. Send orders to:

Order Department

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y.

Station insulators are a capital investment for a power company. How is such an investment evaluated?

This is a long-term investment. TIME is a much bigger consideration than price, since the number of dollars involved is small in the over-all picture, and the difference in price between various makes of insulators is still smaller, by virtue of competition. Therefore, the question resolves itself simply into buying the largest possible piece of the future with today's dollars.

Can it be shown, sensibly, that one insulator has any better future than another? If so, such an insulator has the highest "investment value".

You can't predict the future by laboratory test. But don't forget, today *is the "future"* of thousands of insulators bought twenty years or more ago. The performance of those old-timers is part of the records of power companies. We can't change it. On the basis of that record, new insulators are bought. Therefore, this becomes significant — a great percentage of all orders for O-B station insulators comes from past users; people who have waited for the future, kept track of it, and are now cashing-in on what they have learned.

Just remember, new insulators are at least outwardly the same. Industry Standards assure this. But, no standard deals with the future, and the value of your insulator investment is measured by *how long they stay new.* When TIME is what you're buying, you get the biggest piece of it by specifying "O-B".

Ohio Brass

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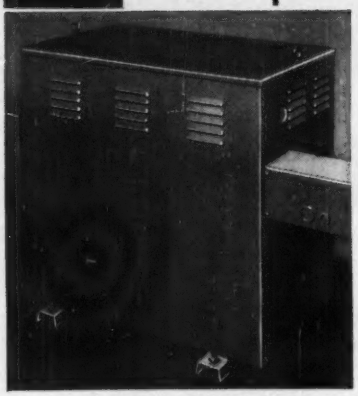
MARCUS dry type TRANSFORMERS ...power this "Electronic Brain"

As the power source of Remington Rand's famous *UNIVAC* (Universal Automatic Computer), MARCUS TRANSFORMERS perform their valuable function within this Electronic Brain.



MARCUS 100 KVA 3 phase transformer powers *UNIVAC*

Every MARCUS dry-type Transformer . . . whatever its class and for whatever its purpose, is constructed to far exceed its particular specification demands. Every detail and component of MARCUS dry-type transformers is carefully engineered for *longer life* and uninterrupted trouble-free performance!

MARCUS Series 5000 dry-type "Class B-plus" Transformers are designed to exceed specifications by approaching "Class H" insulation, yet operating at "Class B" temperatures.

Capacities from 1 to 3000 KVA

- DISTRIBUTION
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- ELECTRIC FURNACE
- RECTIFIER
- WELDING
- MOTOR STARTING
- SPECIAL

CHECK THESE MARCUS B-PLUS FACTORS FIRST!

- *Higher Dielectric Strength!*
- *Greater Protection Against Surges!*
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- *Greater Capacity for Overloads!*
- *Quieter Operation!*
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TELEMETERING COMMUTATORS

Precision-engineered to sample at rates as high as 1800 per second, Giannini Commutators are ideal for use in such applications as radio and wired telemetering—automatic programming—sequence switching—synchronization of mechanical motion with electrical operation. Rhodium-plated printed circuits of almost endless variety meet individual requirements—and switching may be either "make-before-break" or "break-before-make".

Available as either single or double pole model—with up to 60 channels per pole. Dustproof construction and an unusual contact cleaning device keep the switch noise-free during an exceptionally long life.

Incorporates all the features of the 85561—and is motor driven at a constant speed, governor-controlled; at variable speed controlled linearly with applied voltage; or with other special drives.

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ASA, AIEE, and NEMA STANDARD

Projection of load growth and of maximum fault current may indicate the selection of breakers of far higher rating than present load requires.

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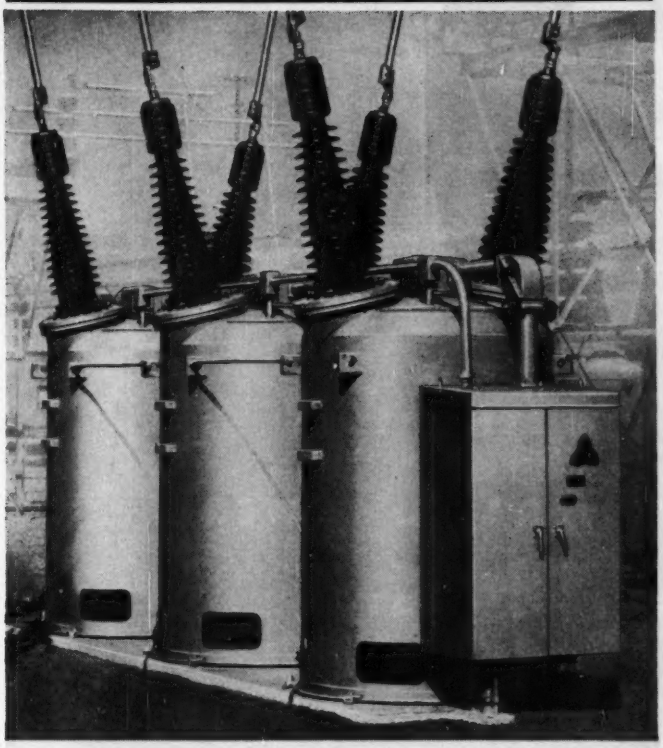
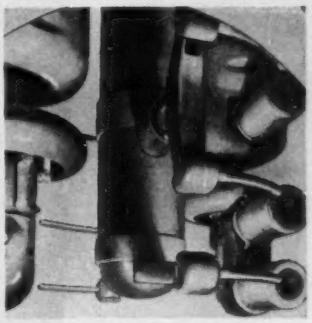
196/230, 230, and 287 kv — 3 cycles
to 10,000,000 interrupting kva (ASA)
at 161, 230, and 287 kv

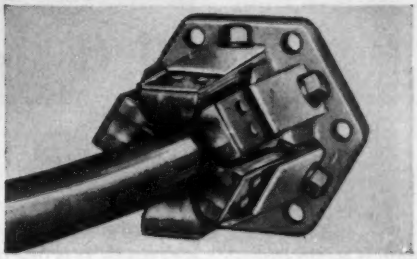


At Left:
One of Fifteen Type RHE-78, 161 kv, 10,000,000 int. kva for Electric Energy, Inc., Joppa, Illinois.

At Right:
Interior of Tank; a single rotary structure connects six interrupters in series (three are shown).

Below:
Moving Contact Entering Nest of Six Sliding-Shoe (finger) Contacts.





These features contribute to Pacific's Proved Protective Performance . . .

Nested Sliding-Shoe Contacts

PACIFIC'S Continued use of the reliable nested sliding-shoe (finger) form of contact, even for the largest circuit breakers, is now supported by the industry trend when severe conditions are to be met.

The stationary and moving contact surfaces of the contacts are silver Elkonite, of such form that arc foot prints are confined to portions of the surfaces that do not carry load current.

The stationary contact structure of each pole comprises six sets of contacts in series, each of either four or six shoes, depending on rating. Voltage division between the sets of contacts is aided by capacitance grading shields.

Proved Interrupters

Pacific interrupters are of simple self-pressurizing type; their exceptional performance is due to improved utilization of directed oil flow and to high speed of developing open-gap distance.

Other Features

- Only one moving structure within the tank.
- Opening accelerating springs and shock absorbers are outside of the tank.
- Oil-hydraulic restoration of closing energy.
- Easy manual emergency operation for load switching as well as for test.
- Electrically and mechanically trip free in any position, even during high-speed reclosing.

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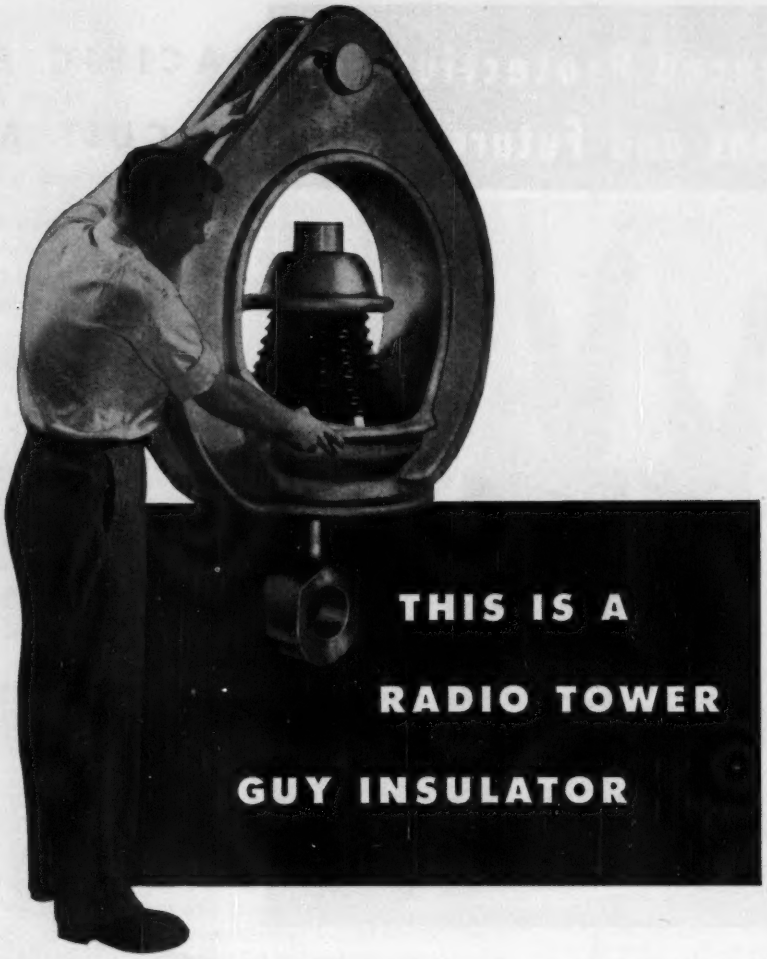


This is probably the largest and strongest strain insulator ever made. It is one of an order for 50 such units to be installed in guys for a giant transmitter antenna. Weighing 1340 lbs., it is to be used with a 2¼" steel strand cable, and is designed to break the cable before failure of the insulator—frame or porcelain.

Most of the world's vertical radiators for radio transmission are insulated by Lapp units—both footing and guy insulators . . . which Lapp originated and have produced in considerable volume for nearly 25 years. All have incorporated the Lapp porcelain "compression cone," a design which utilizes to fullest extent the enormous strength of porcelain in compression. When properly mounted, Lapp porcelain attains a compression strength in excess of 100,000 lbs. per square inch.

But basic to such strengths is "proper mounting." In Lapp radio insulators, proper mounting means external attachment of hardware, a design conception which provides that thermal changes between parts, as well as external loading, load the porcelain in compression.

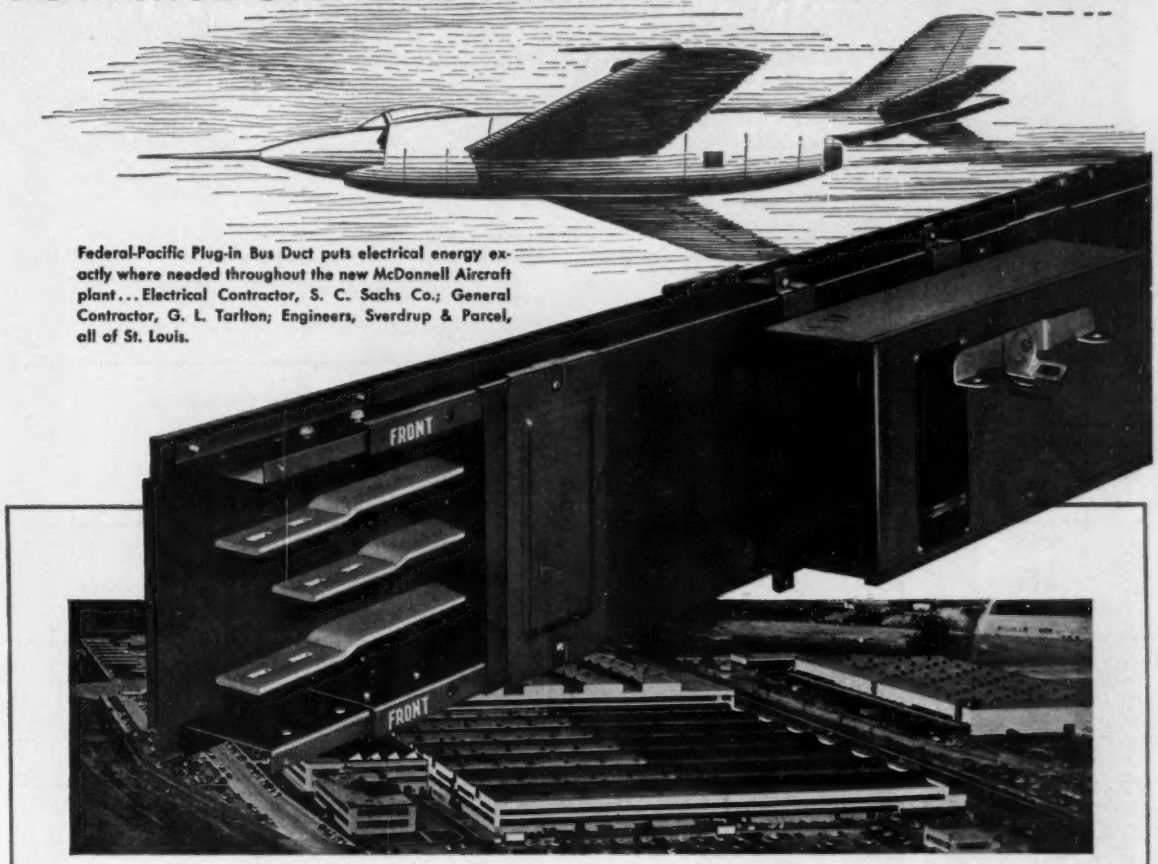
External attachment of hardware, you'll notice, is also the design conception of the Lapp Line Post and Station Post, and a reason why these insulators so greatly outperform multi-part internally-attached-pin insulators.

This is one of the things we mean when we say that Lapp has an understanding of porcelain, its virtues and its strengths as well as its limitations . . . and an ability to design and produce assemblies that assure greater operating security, longer life, lower upkeep.

Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

IT'S FEDERAL-PACIFIC BUS DUCT FOR McDONNELL AIRCRAFT'S NEW PLANT



Federal-Pacific Plug-in Bus Duct puts electrical energy exactly where needed throughout the new McDonnell Aircraft plant... Electrical Contractor, S. C. Sachs Co.; General Contractor, G. L. Tarlton; Engineers, Sverdrup & Parcel, all of St. Louis.

McDONNELL AIRCRAFT CORPORATION of St. Louis, builders of the famous Voodoo, Banshee, and Demon jet fighter planes, will soon occupy a big new Navy plant. Designed to house the receiving, fabrication and machine shop operations, this plant has the most modern equipment including nearly three miles of Federal-Pacific Low Impedance and Plug-in Bus Duct... plus two unit substations and necessary panelboards.

Federal-Pacific's standard line of bus duct is well known for installation ease, low-cost maintenance, and operational convenience. What's more, Federal-Pacific, with its unsurpassed experience, is exceptionally well qualified to design and produce special bus duct for the requirements of particular applications.

To assure top results on every bus duct electrical distribution system, write for descriptive literature on Federal-Pacific Bus Duct... and for similar literature on any other electrical control equipment in which you are interested throughout the whole range from 110 volts to 300 kv. Federal Electric Products Company, 50 Paris St., Newark 5, N. J.

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Federal products: Stab-lok Circuit Breakers, Motor Controls, Safety Switches, Service Equipment, Industrial Circuit Breakers, Panelboards, Switchboards, Control Centers, Bus Duct — **Pacific Electric products:** High voltage circuit breakers and power switches ★ Sales offices in principal cities.

News about

B. F. Goodrich Chemical *raw materials*

GEON PLASTICS FOR WIRE AND CABLE

that meet Underwriters' Specifications

The Geon vinyl insulating compounds listed here were developed to meet the exacting needs of the electrical power industry and equipment manufacturers. The versatile Geon polyvinyl materials can handle many other difficult jobs. For further information, please write Dept. GS-4, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Type Designation	Type of Wire	Wire Size (AWG)	Recommended Insulation	Typical End Use
T	Single Conductor	#14 and larger	2042, 2046, 8600, 6373	Building wire—general
TW	Single Conductor	#14 and larger	2042, 2046, 8600, 6373	Building wire—wet locations
Appliance Wire 80°C	Single Conductor	26-16	6373, 8449	Machine tool wire, radio hook-up wire
90°C	Single Conductor	26-16	6373, 8630	Machine tool wire, radio hook-up wire
105°C	Single Conductor	26-16	8630	Machine tool wire, radio hook-up wire
SPT-1	Parallel Cord	18	8620, 2042, 2046, 8650, 6373	Cord for radio, refrigerator, lamps, etc.
SPT-2	Parallel Cord	18-16	8620, 2042, 2046, 8650	Cord for electric blankets, floodlights, commercial radio receivers
FXT	Single Conductor	20	8620, 8550, 2042, 2046	Christmas tree wire—indoor use
XT	Twisted Pair	20	8620, 8550, 2042, 2046	Christmas tree wire—indoor use
CXT	Twisted Pair	18	8620, 2042, 2046	Christmas tree wire—outdoor use
SPT-3	Refrigerator Cord Parallel Type	18-16	2042, 2046, 8650	Refrigerator lead-in cord
SVT	Vacuum Cleaner Cord	18	2042, 2046, 8600, 8650, 6373	Vacuum cleaner cord
SJT (60°C rating)	Junior Hard-Service Cord	18-16	2042, 2046, 8600, 8650	Cord for large fans, centrifuges, washing machines
ST	Hard-Service Cord	18-10	2042, 2046, 6373, 8600, 8650	Cord for commercial floor polishers and sanders
TF	Single Conductor	18-16	2042, 2046	Electrical fixture wire
TFF	Single Conductor	18-16	2042, 2046	Electrical fixture wire

Jacketing Applications

Application	Recommended Geon Plastic
Coaxial cable jacket	
General purpose	8650, 80968
Non-contaminating	8070, 8720
Low temperature jacket	6281, 6311, 8652, 8677
High temperature jacket	8070
Flame resistant jacket	1911, 8650
General purpose jacket	8620
Appliance cord	2042, 2046, 8332, 8650

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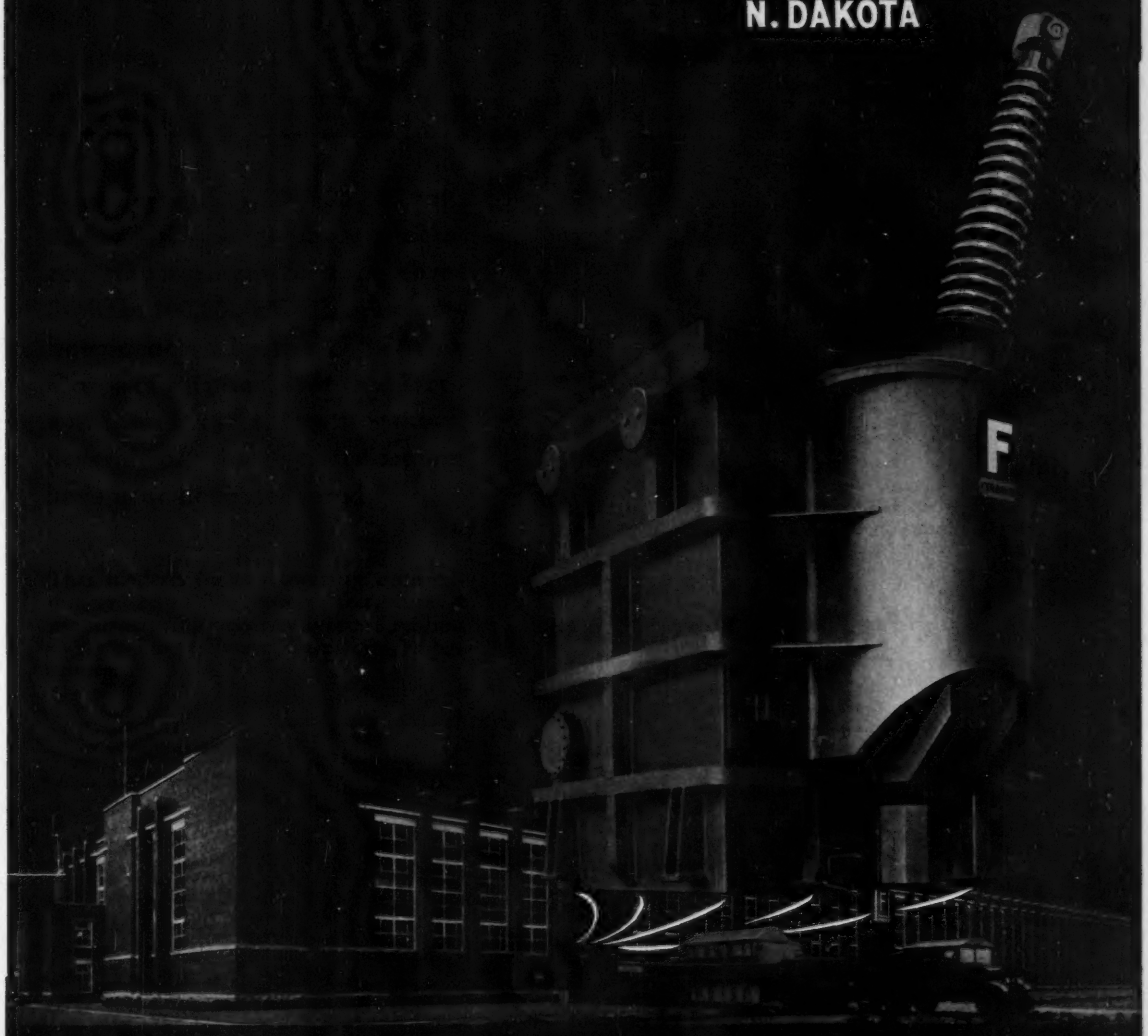

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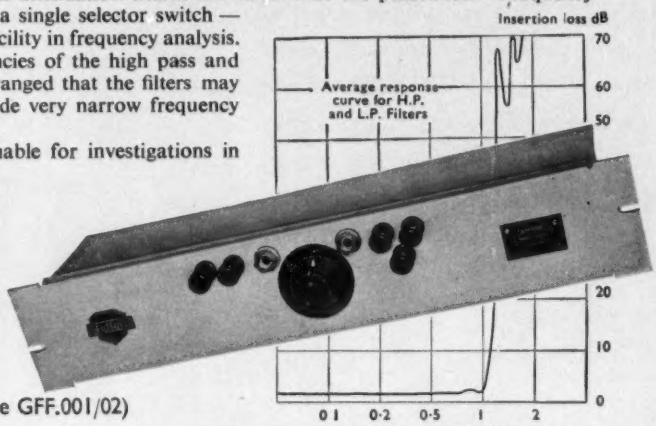
TEN CUT-OFF FREQUENCIES IN ONE COMPACT PANEL

THESE Mullard variable cut-off filters, originally developed in conjunction with the British Post Office, represent a marked advance in filter technique. New design features together with the use of Ferroxcube pot cores have resulted in a valuable reduction in panel size, as well as high attenuation characteristics outside the passbands. Frequency ranges are controlled by a single selector switch — an especially important facility in frequency analysis.

The ten cut-off frequencies of the high pass and low pass filters are so arranged that the filters may be used in pairs to provide very narrow frequency samples.

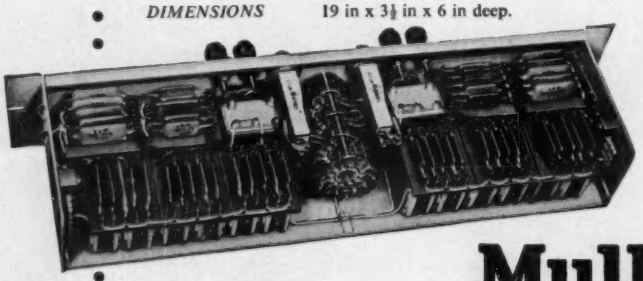
These filters are invaluable for investigations in communications work where it is necessary to limit frequencies, as for example in the measurement of filter attenuation and amplifier distortion.



f/fc (low-pass) and fc/f (high-pass)

High-Pass Filters (Type GFF.001/02)

CUT-OFF FREQUENCIES (fc)	440, 660, 990, 1480, 2222, 3333, 5000, 7500, 11250, 16800 c/s selected by 10-way switch
IMPEDANCES	Input and output 600 ohms, balanced or unbalanced
STOPBAND ATTENUATION	At 0.8 x fc — 50 dB At 0.6 x fc — 60 dB
PASSBAND ATTENUATION	3dB ± 1 dB from 1.1 x fc to 20 or 25 kc/s depending on cut-off frequency (fc)
DIMENSIONS	19 in x 3½ in x 6 in deep.



Low-Pass Filters (Type GFF.001/01)

CUT-OFF FREQUENCIES (fc)	400, 600, 900, 1350, 2025, 3040, 4500, 6830, 10250, 15400 c/s selected by 10-way switch
IMPEDANCES	Input and output 600 ohms, balanced or unbalanced
STOPBAND ATTENUATION	At 1.25 x fc — 50 dB At 1.35 x fc — 60 dB
PASSBAND ATTENUATION	2dB ± 1dB from 50 c/s to 0.9 x fc
DIMENSIONS	19 in x 3½ in x 6 in deep

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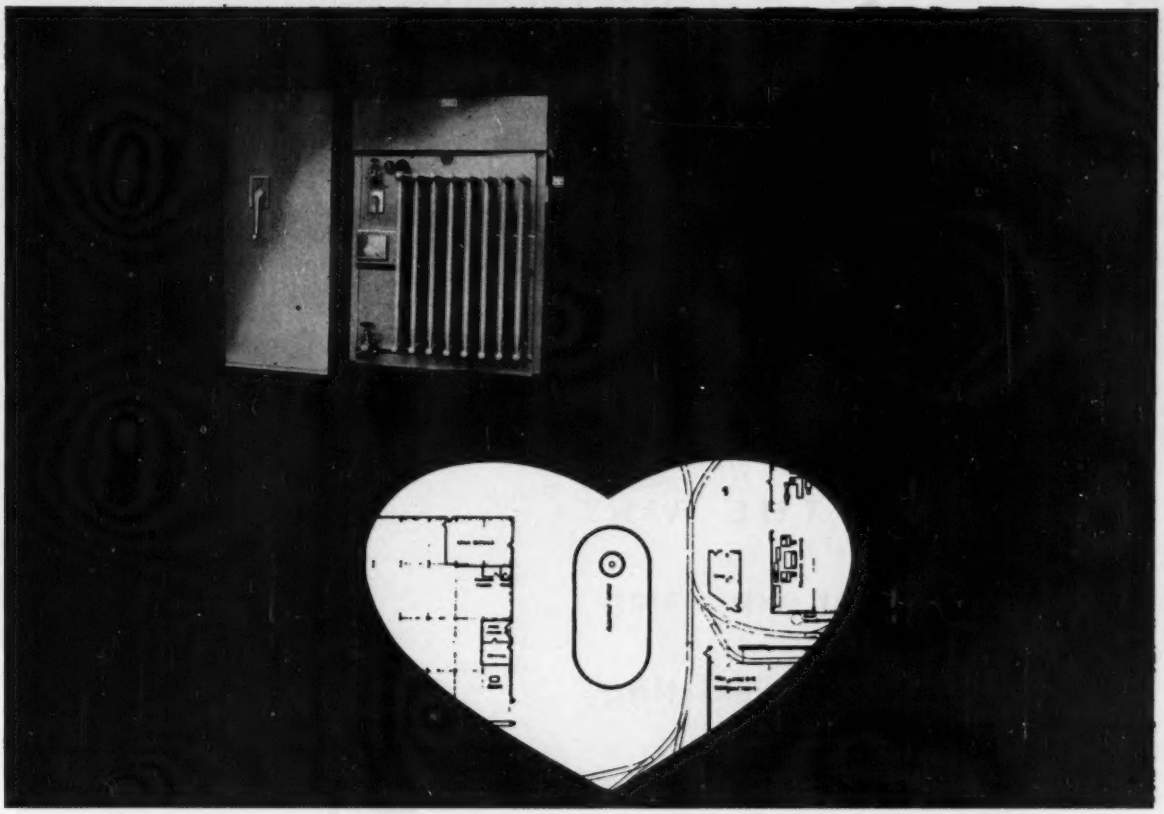

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an UPTEGRAFF LOAD CENTER TRANSFORMER

reduces costs...improves power characteristics

Uptegraff announces a complete line of *Liquid Filled* LOAD CENTER TRANSFORMERS—150 KVA to 2500 KVA, 3 phase—designed for convenient installation with various types of switching equipment and terminal arrangements.

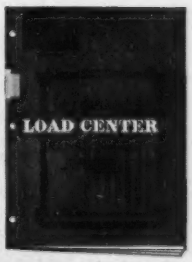
The use of Uptegraff Load Center Transformers offers savings up to 15 per cent as compared to the practice of using remote outdoor transformers to supply low-voltage power to machines and equipment located indoors. With load center transformers, costly low-voltage runs are kept to the minimum, and power characteristics are improved.

Uptegraff Load Center Transformers are designed and built specifically for this class of service. In addition to savings in installation costs, they offer substantial economies through operating efficiency. They are dependable and require the minimum of maintenance.

R. E. Uptegraff Manufacturing Co.

Scottdale, Pennsylvania

NEW HANDBOOK



The new Uptegraff Load Center Transformer Handbook simplifies the selection of a suitable unit, including auxiliary terminal equipment to provide the facilities you require. It gives overall dimensions and weights (including terminal devices, etc.) for all ratings from 150 to 2500 KVA,—3 phase. Write for a free copy. The coupon below is included for your convenience.

R. E. Uptegraff Manufacturing Company
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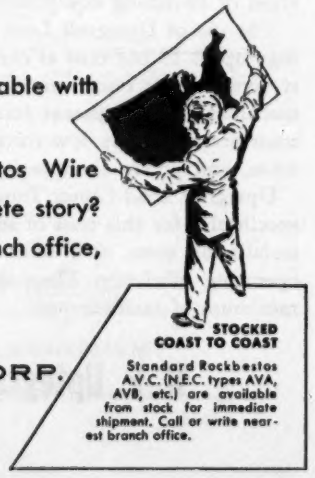

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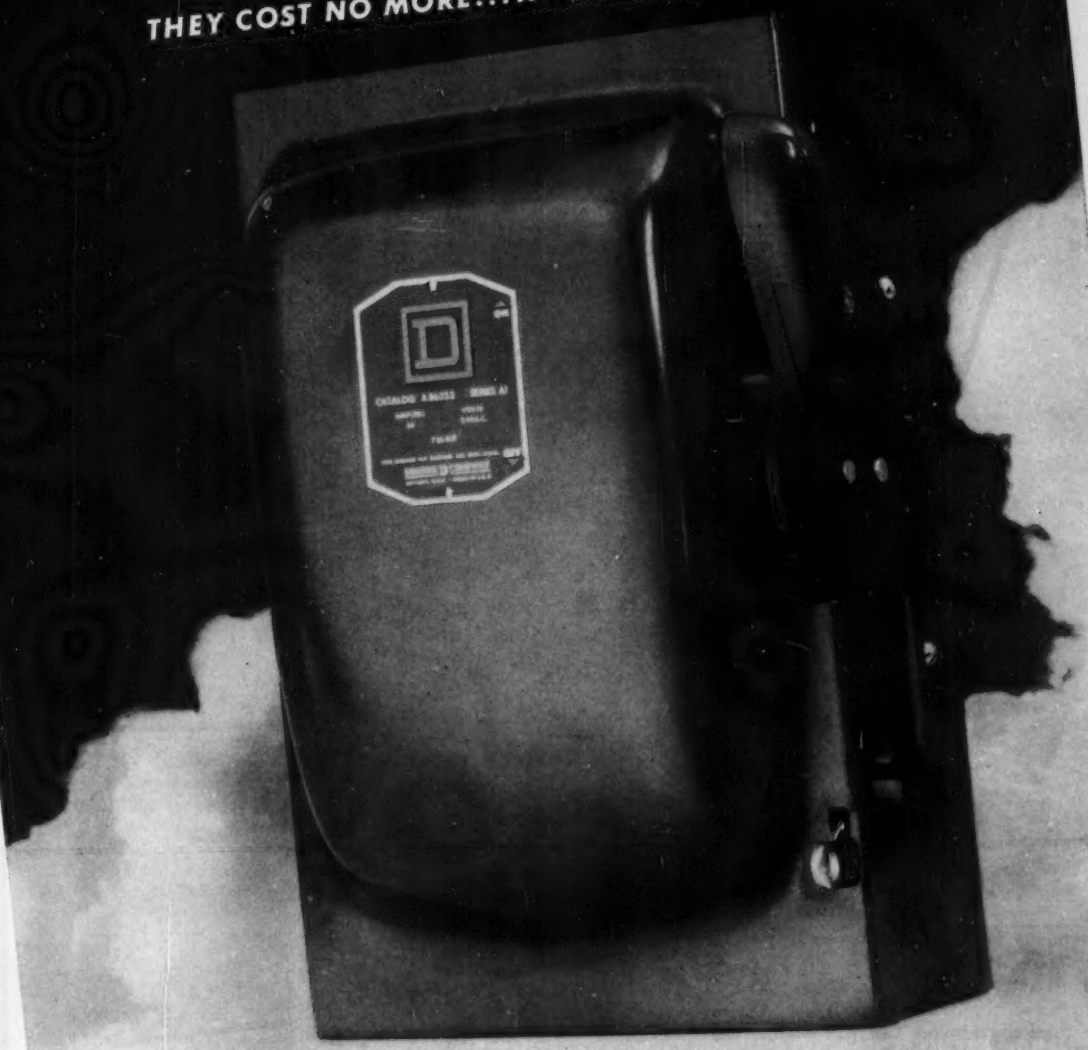

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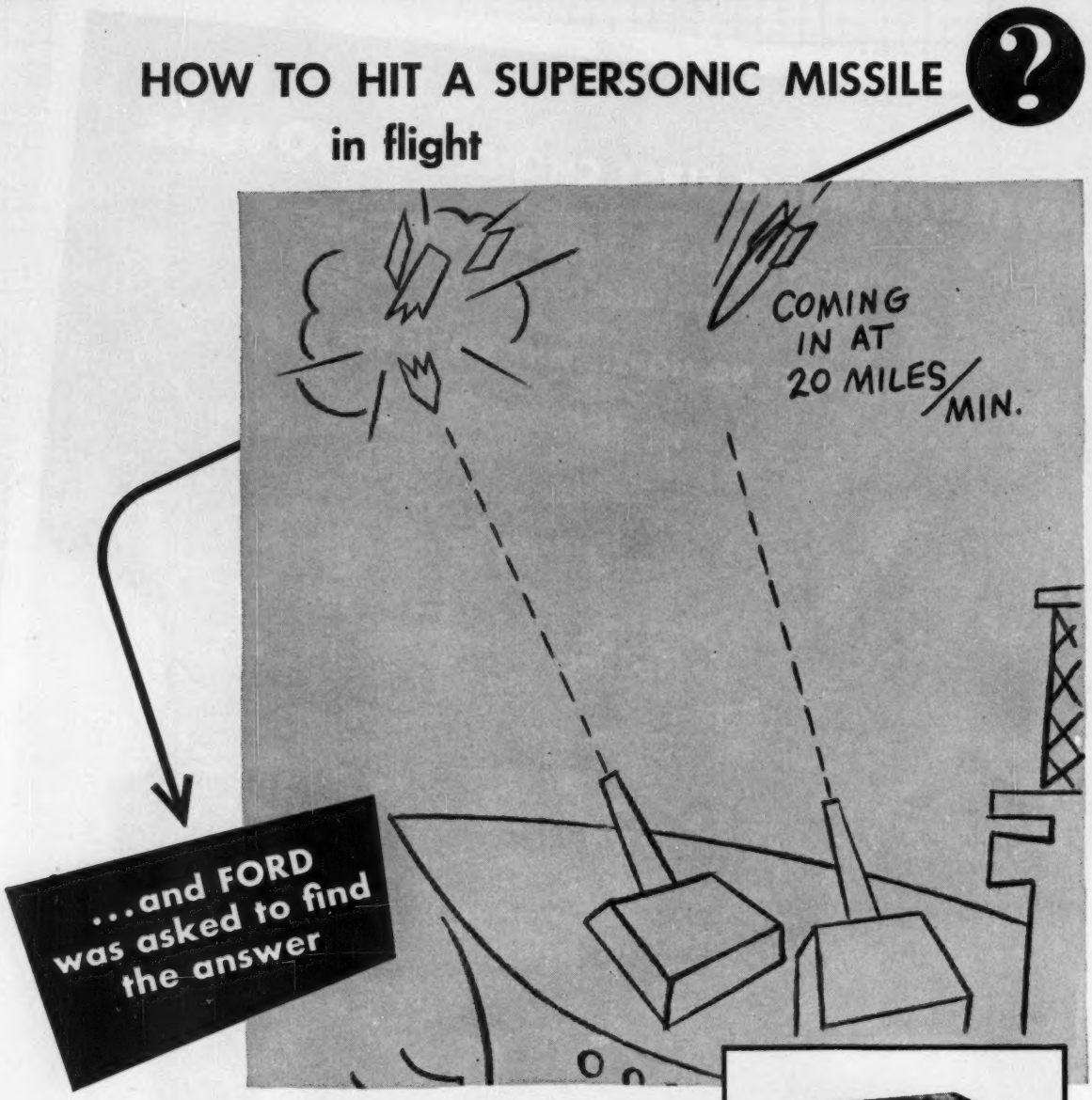

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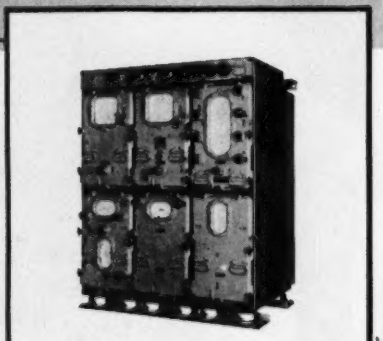

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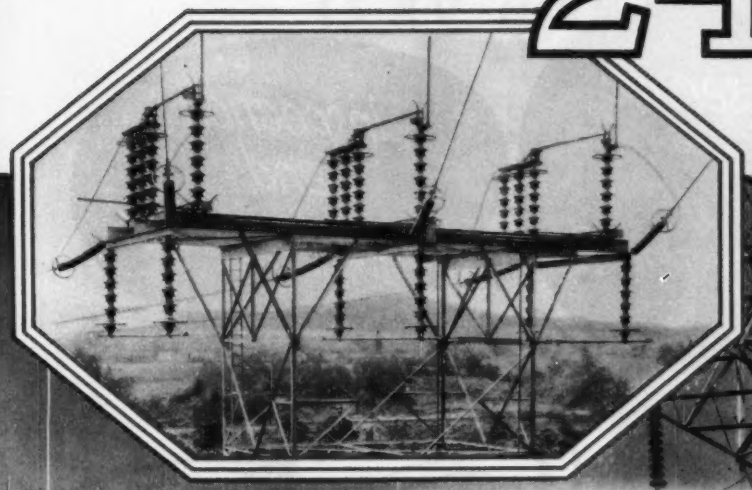

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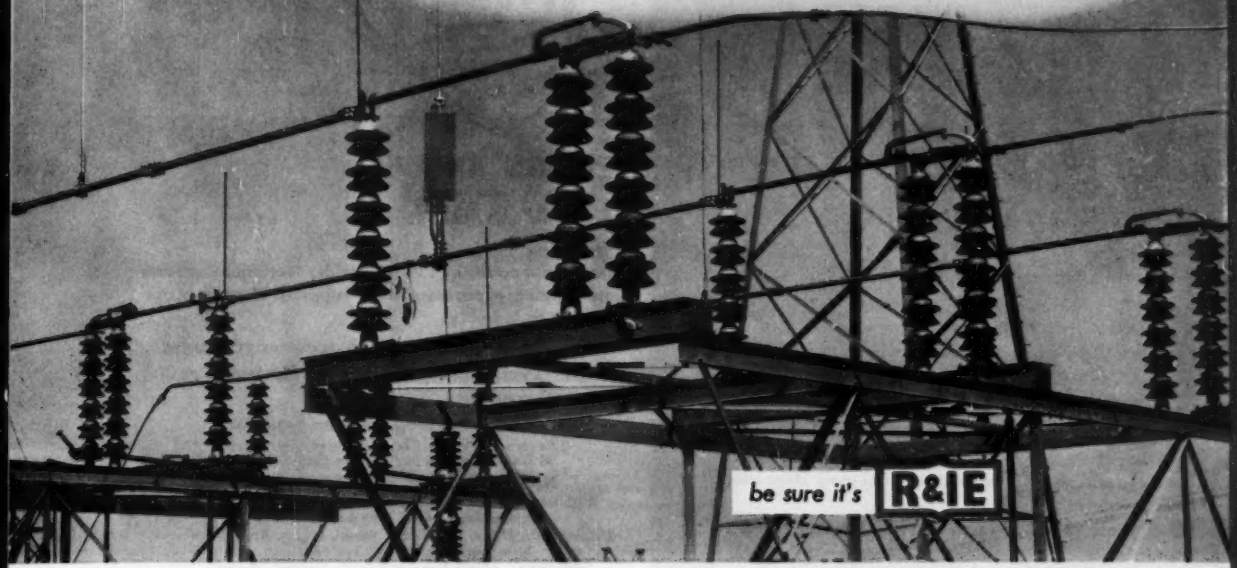

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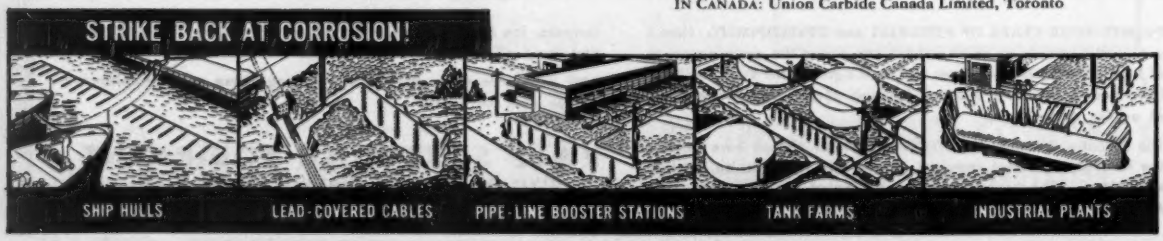

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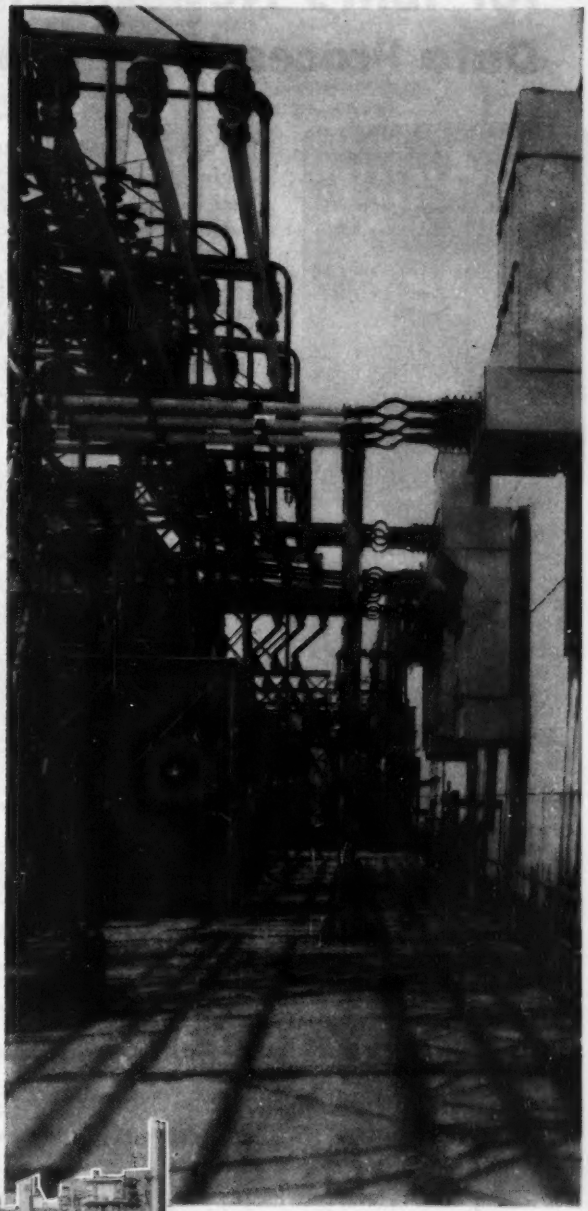

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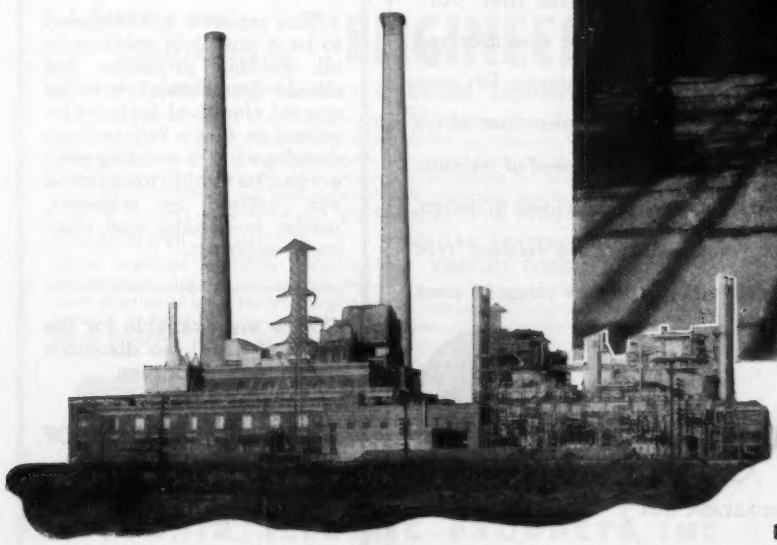

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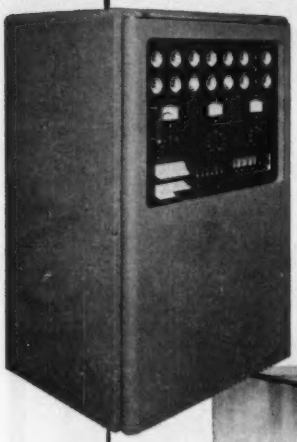

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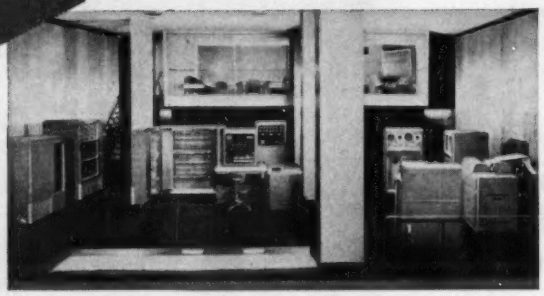

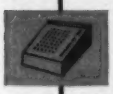

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Power Supply for Resistance Welding Machines

(April 1952)

AIEE Special Publication S-45 is a report of the AIEE Subcommittee on Power Supply for Resistance Welding Machines. Recognizing that the installation and use of any resistance welding process vitally concerns not only the industrialist requiring the process but also the welding machine manufacturer and the utility supplying the electric power as well, the committee has in this report brought together much pertinent data from the knowledge, literature, and experience in all these fields.

This publication supersedes the AIEE reports of the same title presented in 1940–1. The new work is required by developments in welding machines, new processes, better analysis of certain phenomena (such as measurement of instantaneous loads, and interference between welders), and a clearer understanding of the whole problem of power supply for resistance welders.

This report is not intended to be a complete solution of all welding problems, but should direct attention to the special electrical features involved so that a full analysis developed for a welding project can be readily understood and utilized by manager, master mechanic, and electrical engineer.

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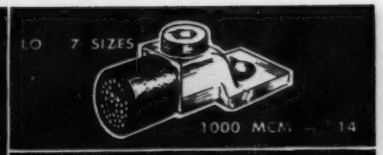

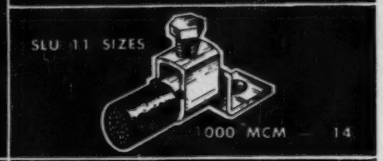

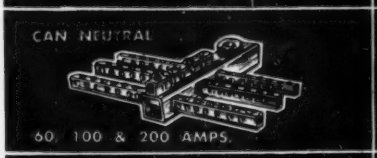

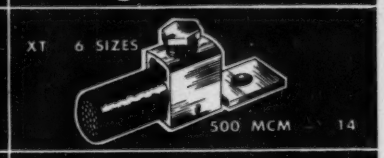

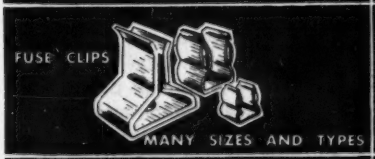

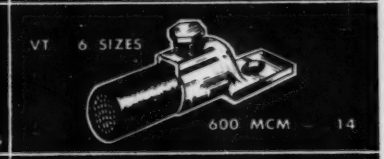

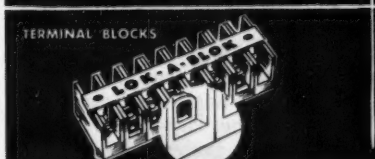

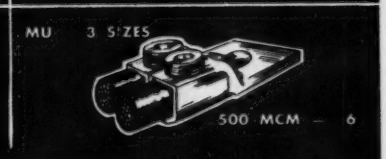

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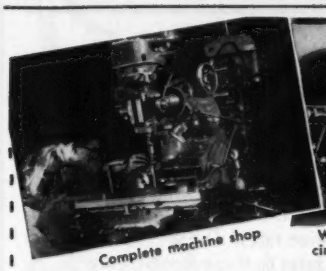
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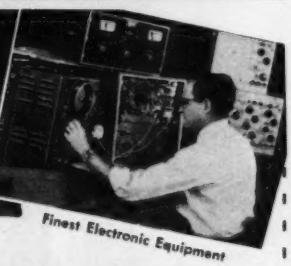
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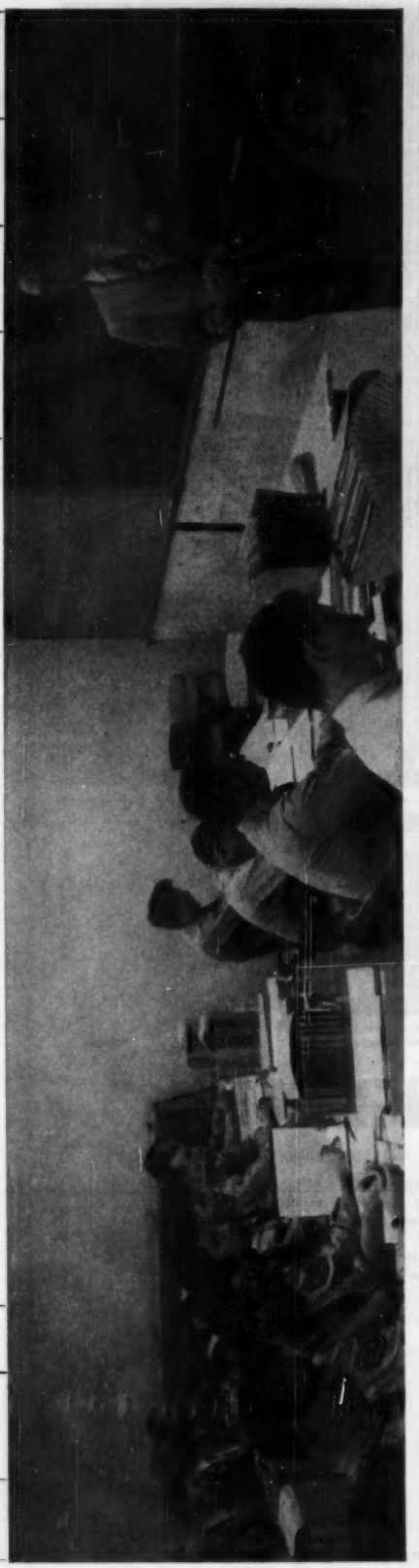

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PROJECT ENGINEER, electrical, for central engineering department, to conduct studies, do estimates, design procurement and supervision of preliminary operations for factory power systems and process control installations. Salary dependent upon qualifications. Location, Michigan. W-23.

ENGINEERS. (a) Electrical Engineers experienced in radio communications. Must have HF, VHF and micro-wave experience and/or telephone and telegraph terminal equipment experience. Duties will be design and supervision of radio systems in foreign countries. Salaries for experienced engineers, $6000 and up a year. (b) Trainees, with electrical engineering degrees and option in communications, to become qualified assistant engineers for eventual assignments abroad. Salary, $4420–$5100 a year. Assignments will be any place throughout the world and applicants must be prepared to travel. Headquarters, New York, N. Y. F-45.

DEVELOPMENT ENGINEER, must be graduate electrical, with over five years' experience in one or more of the following fields. Digital computers, servomechanisms, gyros, infra red, guided missiles, rockets and torpedoes. Must be citizen of U. S. Salary, $7000–$10,000 a year depending upon experience. Location, New York, N. Y. W-62.

NOISE AND ACOUSTICS ENGINEER, 28–35, prefer M.S. in Physics but will accept M.S. in electrical engineering or M.S. in mechanical engineering; three to five years' engineering experience in industrial equipment noise control and architectural acoustics. Will provide consulting services on noise and acoustical problems in industrial plants. Salary commensurate with experience. Location, Delaware. W-77.

TECHNICAL WRITER, electrical graduate, experienced in the writing of technical manuals. Background in analogue computers, radar and optics required. Some travel. Salary open. Location, six months in upstate New York; then New York City. W-93.

DEVELOPMENT ENGINEER, graduate electrical, with two to three years' experience in electronics, for experimental process engineering section. Job consists of developing and designing the application of electronic controls for various types of machines used in quality control and setting up service policies on present equipment; some knowledge of power for occasional advice on the subject. Salary, $4800–$5200 a year. Location, Connecticut. W-99.

ASSISTANT MANAGER of electrical sales, 32–40, electrical engineering graduate, with sales and managerial experience covering rectifiers and motor generator sets in low voltage fields. Considerable traveling. Salary, $8000–$10,000 a year plus bonus. Location, East. W-103.

ENGINEERS. (a) Project Engineer to set up and perform system analysis by use of analogue computer equipment. With background of servo theory for dynamic analysis of feed back control systems, as applied to turbojet and turboprop engines. (b) Project Engineer, background in fluid mechanics, to work on hydraulic control development and fuel systems for turbo jet engines. Required to execute design and performance analysis for steady state and transient conditions. (c) Recent graduate, mechanical or electrical, for work with aircraft engine accessory manufacturing company. Salaries open. Location, Connecticut. W-126.

INSTRUCTOR OF ELECTRICAL ENGINEERING, M.S. degree, with interest in power, machinery and servo mechanisms. Will teach basic electrical engineering courses to mechanical and chemical students and circuit courses to electrical engineering students. Salary, $4000–$4900 for nine months plus supplementary income of $800–$1200 from night school teaching. Position starts September, 1954. Location, northern New Jersey. W-132.

SECTION CHIEF, Product, electrical, 30–40, to supervise 30 to 40 people on the design of generators, alternators, wiring, etc. on aircraft. Salary, $10,000–$12,000 a year. Company will pay placement fee. Location, East. W-134(a).

PHYSICIST thoroughly familiar with the processing of Germanium crystals. Salary open. Location, eastern Pennsylvania. W-138.

ELECTRONICS ENGINEER, degree (or equivalent in experience), with a minimum of three years' experience with electronics pulse time measurements, designing such circuits as multiars, pulse, amplitude comparators, gate, blocking and coincidence. Salary,

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$5720–$6300 a year. Location, New York, N. Y. W-153.

JUNIOR ELECTRICAL ENGINEER, 25–30, degree, with one to five years' experience in the metering department of a large utility or manufacturer. Prefer single man. Location, Brazil. F-163.

SENIOR ELECTRICAL ENGINEER, 25–45, B.E.E., with experience in the design of iron core components, transformers (audio power and pulse), reactors and filter networks. Company will pay moving expenses. Salary, $10,000–$15,000 a year. Location, New York State. W-164.

EXECUTIVE DIRECTOR, engineering graduate, with executive managerial and administrative experience in educational, scientific and industrial fields to promote and manage educational activities, conferences, exhibits, meetings, develop technical and industry group activities for technical society. Salary, $12,000–$15,000 a year. Location, East. W-196.

MAINTENANCE ENGINEER, graduate electrical, 35–45, experienced in both mechanical and electrical maintenance in chemical plants. Must be capable of taking complete charge of small steam plant (1400 hp) and the repair, maintenance and new construction work. Must be able to procure at least a second class stationary engineer's license from Massachusetts. Location, Massachusetts. W-201.

SALES MANAGER with at least five years' experience in sales management of heavy transformer (power). Duties will require heading up sales organization of about 20 men selling mostly to contractors and O.E.M.s. Company manufactures transformers. Salary, $8000–$9000 a year plus override. Employer will negotiate fee. Location, Chicago, Illinois. C-1951.

APPLICATION ENGINEER, electrical, 25–30, with at least two years' experience in utilities or heavy industrial users of power. Knowledge of high-voltage equipment. Duties will include application work in sales department of manufacturer of high voltage equipment. Can lead into sales eventually if desired. Employer will pay fee. Salary, $4800–$7200 a year. Location, Chicago, Illinois. C-1966.

ADMINISTRATIVE ENGINEER, 40–45, with at least five years' experience in administrative capacity for utility handling power production, transmission and distribution operations. Duties will include administrative work with an electric utility servicing 125 central states area communities and 100,000 customers. Salary $12,000 a year. Location, Midwest. C-1987.

WELDING SALES ENGINEER, up to 32, with at least one year's experience in industrial sales or application of welding products. Knowledge of electrical equipment helpful. Will handle full line of welding equipment for well known manufacturer getting into the field with a new line. Salary, $4800–$6000 a year. Car required; 20% traveling. Headquarters, Chicago, Illinois. C-2025.

INSTRUCTOR, general engineering, to teach primarily drawing and descriptive geometry. Candidates must have engineering degree and be eligible to enter graduate college. Salary commensurate with training and experience. Previous teaching experience not required. Position permanent with opportunity for advancement. Location, Illinois. C-2026.

DISTRIBUTION ENGINEERS—Two competent experienced graduate Electrical Engineers, with approximately 10 years experience design, operation and maintenance of distribution facilities in established rapidly growing utility located South America. Reply giving resume education, experience and personal data. Box 149.

METER SUPERINTENDENT—Established rapidly growing utility in Brazil requires competent technician with 10 years experience Meter Department of U.S. or large Latin American Public Utility to supervise Meter Departments several operating companies. Single man preferred as considerable traveling involved. Reply giving resume education, experience and personal data. Box 150.

TEACHING POSITIONS for September 1, 1954, are available at a University in the Southeast. Associate Professor, $5,500–$9,400; Instructors, $3,500–$4,300; Graduate Assistants (M.S. in 12 months), $110 per month, tuition free. Box 152.

LOAD DISPATCHER—Established growing utility in one of the most desirable locations in Brazil desires temporary services (about one year) of experienced technician to initiate dispatching service and train local personnel in its operation and maintenance. System is combination thermal and hydro with transmission up to 132 kv. Excellent opportunity for active retired experienced chief load dispatcher. Reply giving education, experience and personal particulars. Box 158.

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JUNIOR ELECTRICAL ENGINEER—single, 25–30 years of age with 1–5 years experience in Metering Department of a large public utility or manufacturer Location Rio de Janeiro, Brazil. Box 178.

INSTRUCTOR—M.S. in E.E. with 2 years industrial or teaching experience. Salary to $4,900 for 10 months. Opportunity for increase by $1,000 for night teaching. Location Greater New York area. Box 184.

INSTRUCTOR IN ELECTRICAL ENGINEERING—Man with M.S. degree in E.E. to teach undergraduate courses in that field. Some experience in teaching or research is desirable. Must be U.S. citizen. To start September 15, 1954. Salary $4,200 a year (actually for about 9 months). Technical college in the New York Metropolitan Area. Box 186.

GRADUATE ASSISTANT—Opportunity for a young man with a bachelor's degree in Electrical Engineering to obtain a master's degree while gaining teaching experience; this usually takes 2 years. U.S. citizen preferred. To start September 15, 1954. Salary $1,500 for 9 months; no charge for graduate tuition. Technical college in the New York Metropolitan Area. Box 187.

ELECTRICAL ENGINEER—JUNIOR OR ASSISTANT DISTRIBUTION ENGINEER. Technical graduate with at least 3 years field experience operating utility company. Permanent position with long established consulting organization New York. Some travel Latin America necessary in future. Knowledge of Spanish or Portuguese useful. Salary commensurate with experience. Reply stating age, education, experience and personal particulars. Box 189.

ELECTRICAL ENGINEER—Technical graduate, maintenance and operating experience at least 5 years in field work on maintenance and operating problems of generating stations and substations of operating public utility companies. Permanent position with long established consulting organization New York. Some travel Latin America. Spanish or Portuguese useful. Salary commensurate with experience. Reply stating age, education, experience and personal particulars. Box 190.

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ELECTRICAL ENGINEER, BEE, age 28, family. Presently employed, 2 years experience hydroplant construction, 1 year power system operation. Desire position with future in utility, industry or engineering firm in West or Middle West. Box 182.

ELECTRICAL ENGINEER, BEE, 9 years experience in repair, design, and development of mechanical, electrical, and electronic equipment. Lieutenant U.S.N. Familiar with aircraft. Personnel experience. Age 31, desire interesting and responsible position. Available October. Box 183.

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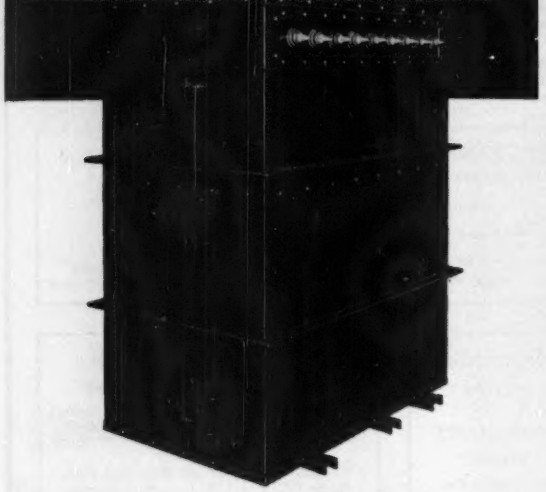

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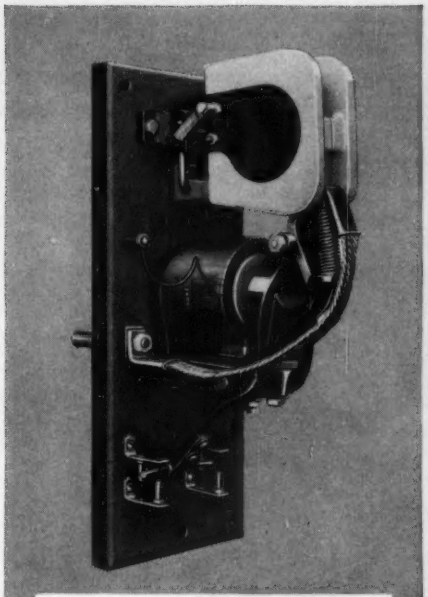

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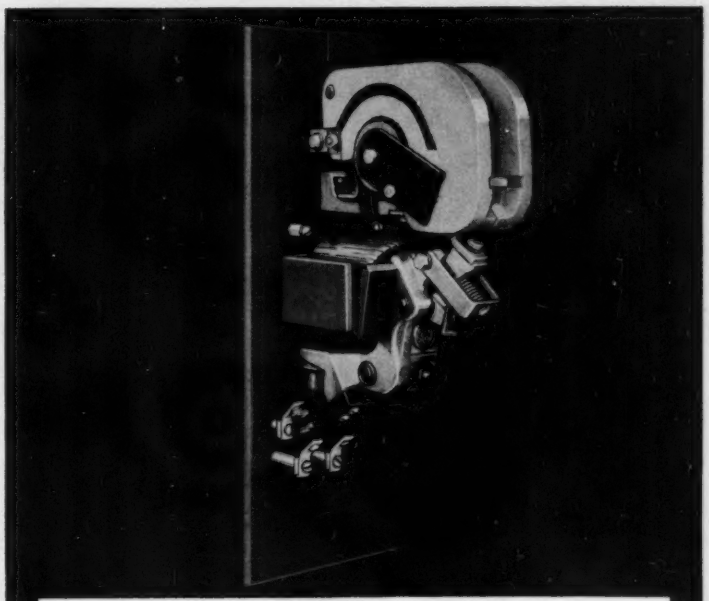

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Cole Electric Co.

8439 Steller Drive TExas 0-4701 Culver City, Calif.

AIR BREAK DISCONNECTING SWITCH
115,000 volts—1200 amperes
Type 0-2
Underhung mounting. Three-pole, single throw.
Group operated. One pole shown.
Silver to silver contacts.

Standard Frequencies

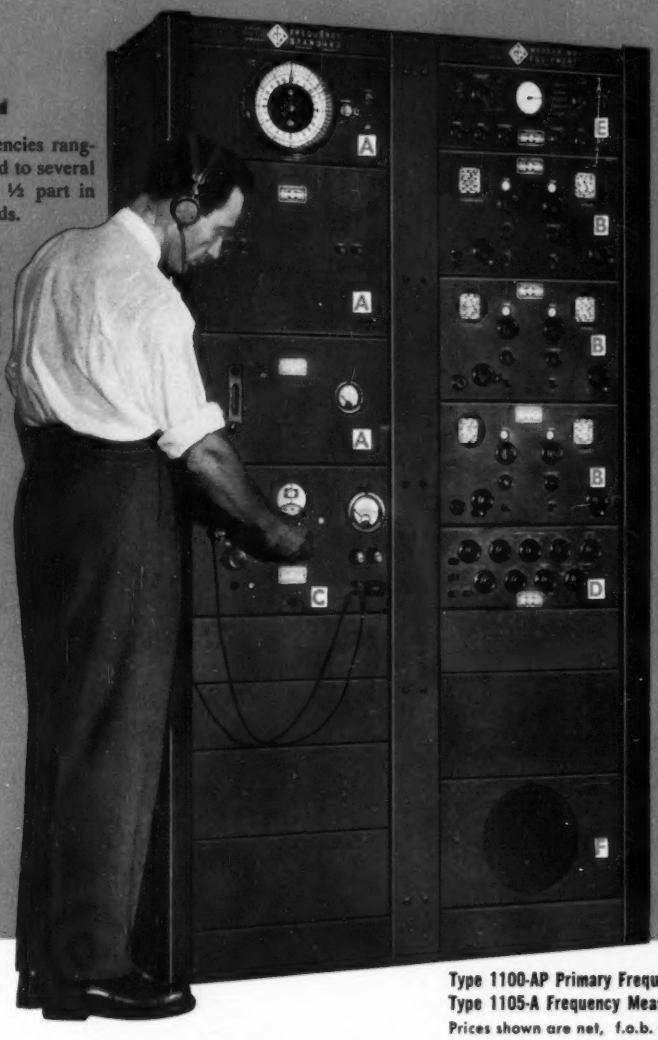
for Measuring 1 part in 100,000,000!

Type 1100-A

Primary Frequency Standard

. . . supplies standard frequencies ranging from one pulse per second to several megacycles . . . accurate to ½ part in 100 million over short periods.

It consists (A) of a 100-kc oscillator, with temperature-controlled quartz bar, multivibrator units for 100 kc, 10 kc, 1 kc and 100 cycles, an a-c operated power supply and a Syncronometer. The Syncronometer's microdial arrangement permits accurate comparison against standard time signals.



Type 1105-A

Frequency Measuring Equipment

directly measures unknown frequencies to 100 megacycles by comparison against one of the hundreds of standard frequencies supplied by the Primary Frequency Standard . . . measurement accuracy is ±0.1 cycles after standardization . . . better than *1 part in 100 million* at higher frequencies.

This equipment consists of:
Three transfer units (B) each containing a heterodyne frequency meter and tuned detector for accurately locating the unknown in terms of one of the 10-kc standard-frequency harmonics. The first three or four significant figures in the unknown are determined in this way.
The Interpolation Oscillator (C) measures the audio-frequency difference between the unknown and a standard 10-kc harmonic, giving the last four figures.
For example, this combined equipment will measure a frequency such as 19,765,839 cycles to ±2 cycles, direct reading, or ±0.1 cycles after standardization.
The Control Panel (D) provides a centralized unit for quickly and conveniently interconnecting all the other elements.
The Comparison Oscilloscope (E) aids in making interpolations, or in checking calibrations with high accuracy.
A speaker (F) mounted on a relay rack is provided for audible monitoring of beat tones.

Type 1100-AP Primary Frequency Standard $2390.00
Type 1105-A Frequency Measuring Equipment $4480.00
Prices shown are net, f.o.b. Cambridge or W. Concord, Mass.

This equipment is the most accurate, commercially-available frequency measuring system obtainable. It supplies usable frequencies of high, known accuracy over an extremely wide range. It incorporates many operating conveniences, and requires little attention or maintenance.

Since 1915 *Manufacturers of Electronic Apparatus for Science and Industry*

GENERAL RADIO Company

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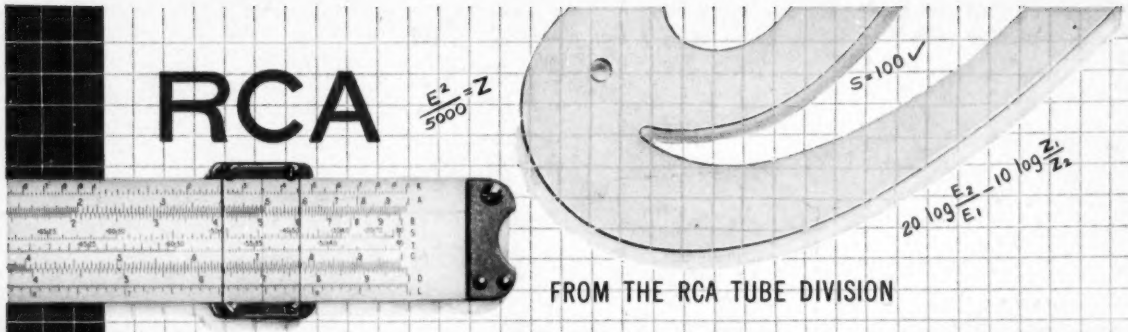
ADMITTANCE METERS	MODULATION METERS	SIGNAL GENERATORS
AMPLIFIERS	MOTOR CONTROLS	SOUND & VIBRATION METERS
COAXIAL ELEMENTS	NULL DETECTORS	STROBOSCOPES
DISTORTION METERS	OSCILLATORS	TV & BROADCAST MONITORS
FREQUENCY MEASURING APPARATUS	PARTS & ACCESSORIES	U-H-F MEASURING EQUIPMENT
FREQUENCY STANDARDS	POLARISCOPES	UNIT INSTRUMENTS
IMPEDANCE BRIDGES	PRECISION CAPACITORS	VARIACS®
LIGHT METERS	PULSE GENERATORS	V-T VOLTMETERS
MEGOHMMETERS	R-L-C DECADES	WAVE ANALYZERS
	R-L-C STANDARDS	WAVE FILTERS

RCA



FROM THE RCA TUBE DIVISION

TECHNICAL NEWS FOR DESIGNERS

New, Small UHF Power Triode
(Liquid and Forced-air cooling)

RCA-6383 is designed primarily for transmitter applications in aircraft where compactness, light weight, and high power output are important. Although it weighs only 8 oz., the tube can handle up to 600 watts of plate dissipation. It can be operated with full plate voltage and plate input at frequencies up to 2000 Mc.

Max. length, only $4\frac{1}{4}$"

The Versatile "Special Red" Rectifier . . . RCA-5690

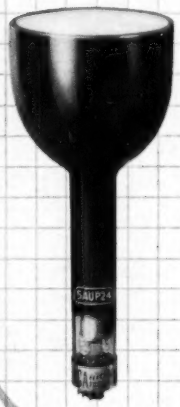
Featuring two separate indirectly heated cathodes to give you two separate half-wave rectifiers in one envelope, the RCA-5690 "Special Red" Tube provides dependable long life and permits simple and economical designs for circuits such as:

- voltage doubler
- reference and signal comparator
- bridge and polyphase circuits
- high-power phasing and sensing circuits
- full-wave negative supplies

For industrial and aircraft circuits where the accent is on long life and dependability coupled with maximum safety and minimum maintenance, you can rely on RCA "Special Red" Tubes.

The 10,000-hour line—
RCA-5690, 5691, 5692, 5693

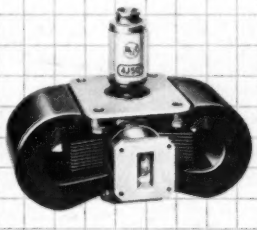
New Flying-Spot Tube for COLOR



RCA-5AUP24 is a 5" cathode-ray tube intended for use as the flying-spot scanner in color-video-signal generators. It features a metal-backed phosphor which has a spectral-energy emission characteristic with peak in the blue-green region and with sufficient range to provide usable energy over the visible spectrum required for generating color-TV signals from color transparencies.

Max. length, $12\frac{7}{8}$"

"Packaged" Magnetron
(Forced-air cooled)



The RCA-4J50 3-centimeter magnetron is intended for use as a pulsed oscillator in radar service. Full anode voltage can be applied directly after heater warmup. The RCA-4J50 incorporates a getter to maintain high vacuum and good arc stability during life.

Frequency 9375±30 Mc

For a 1μ sec. pulse duration and duty cycle of 0.001

Max. Peak Input	635 Kw
Typical Peak Output	240 Kw

For technical data, write RCA Commercial Engineering, Section H16R, Harrison, N. J.

ELECTRON TUBES • SEMICONDUCTOR DEVICES • BATTERIES • TEST EQUIPMENT • ELECTRONIC COMPONENTS

RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N. J.